SIEMENS

# MOBILETT Plus HP

SP

## Service Instructions

From Serial No. 30900

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English

Print No.: SPR8-220.061.03.03.02

Doc. Gen. Date: 09.03

Replaces: SPR8-220.061.03.02.02

| Chapter | Page | Revision |
|---|---|---|
| All | All | 03 |

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## Training of customer support engineers

Due to the technology used in this equipment, setup, service and maintenance should be performed only by customer support engineers who have a work authorization for MOBILETT Plus HP.

## Text emphasis

| | |
|---|---|
| ⚠DANGER | **DANGER indicates an immediate danger that is likely to result in death or serious physical injury.** |
| ⚠WARNING | **WARNING indicates a risk of danger that may lead to death or to serious physical injury.** |
| ⚠CAUTION | **CAUTION used in conjunction with the safety alert symbol indicates a risk of danger that is likely to result in slight or moderate physical injury and/or damage to equipment or property.** |
| NOTICE | **NOTICE used without the safety alert symbol indicates a risk of danger that if disregarded leads to or may lead to an undesirable result or state other than death, physical injury or damage to property.** |
| NOTE | **NOTE contains information that emphasizes proper use of the equipment or proper execution of a procedure, i.e. hints, tips.** |

## Symbols

Checks and adjustments that must be performed with radiation ON are identified by the radiation warning symbol.

This symbol means "Dangerous voltage".

This symbol means "Attention, consult the documentation".

This symbol means equal to or less than.

This symbol indicates components that are sensitive to electrostatic discharge (ESD).

## Required documents

- Wiring diagram SPR8-220.051
- Functional description SPR8-220.041

## Required tools, measurement and auxiliary devices

**NOTE**

**All tools, measurement and auxiliary devices with the exception of those marked " * " are listed along with their specifications in the STC (Service Tools Catalog).**

- Standard service equipment*
- Digital multimeter
- Dose meter
- Storage oscilloscope with ± 2.5 % accuracy
- Torque wrench, 1 Nm - 3 Nm
- Spring scale
- Ceiling support *
- Lux meter
- Protective mat*
- Rope *
- Pulley block *
- Adjustment device for belt tension (Part No. 65 64 301)
- Current transformer (50 A : 50 mA)* (Part No. 31 51 289)
  In addition, a metal film resistor with
  10 Ohms; 0.5 W; 1 % is required*
  Refer also to Speed Info 06/91
- Calibration tool for DAP measuring system (Part No. 65 84 978)

## Lubricants

- All-purpose grease PD 2
- Viscogen oil

## Safety information and protective measures

⚠CAUTION

- **The following items must be complied with when performing service work and tests:**
  - **The product-specific safety information in the documents**
  - **The general safety information contained in ARTD Part 2.**
- **Connect the MOBILETT Plus HP only to a mains power supply outlet (receptacle) that corresponds to the installation requirements of VDE 0107 or to country-specific regulations.**
- **Remove or install boards only when the generator is switched OFF. Adhere to the ESD guidelines .**
- **Checks and adjustments performed with radiation ON are identified by the radiation warning symbol . Radiation protective clothing must be worn for this type of adjustment.**

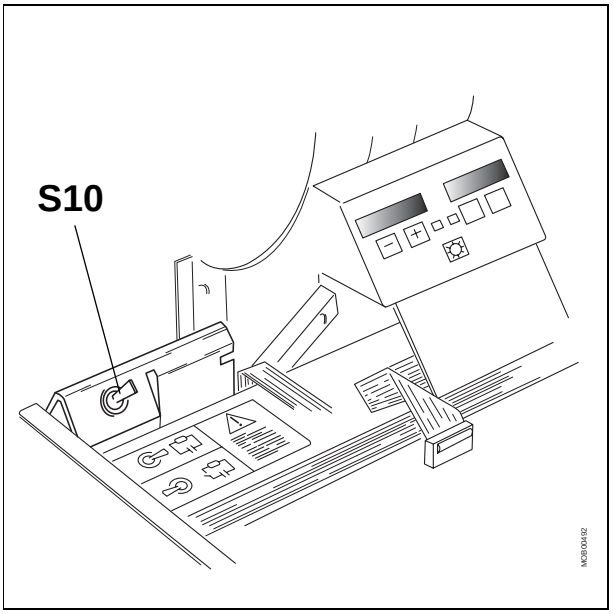



Fig. 1

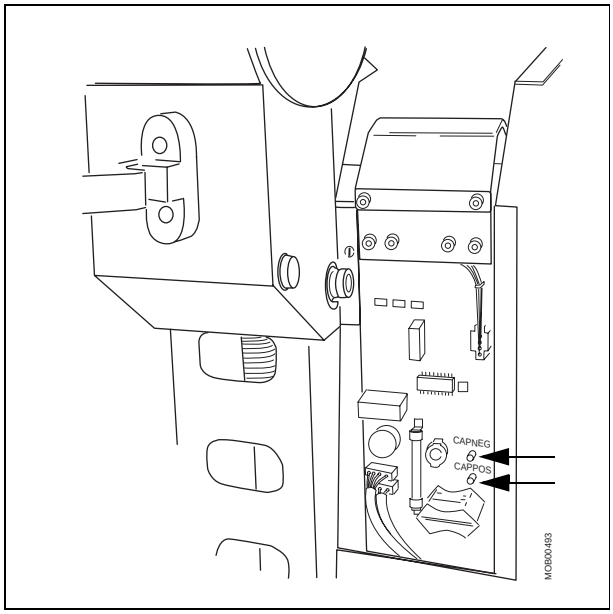



Fig. 2

## Protective measures batteries B10 and capacitors in power conversion unit M10 and M11

Comply with the information given in this section before opening the system.

**⚠DANGER**

**High Voltage!**

**Life-threatening hazard of electric shock. Never work with the system open if the batteries are still connected and the capacitor is charged. If the batteries are connected, the complete system is powered on!**

**The capacitors in M10 and M11 may still be charged even if the system is switched OFF and the mains cable is disconnected. The capacitors in M10 and M11 must be considered charged until the protective measures listed in this section have been performed.**

- System OFF (turn the main switch to **C**).
- Disconnect the mains cable.
- Remove the system upper cover.
- Discharge the capacitors in M10 and M11 with S10 (D7) (Fig. 1).

Wait 5 minutes; then remove the left and right covers and the cover with the cassette compartment.

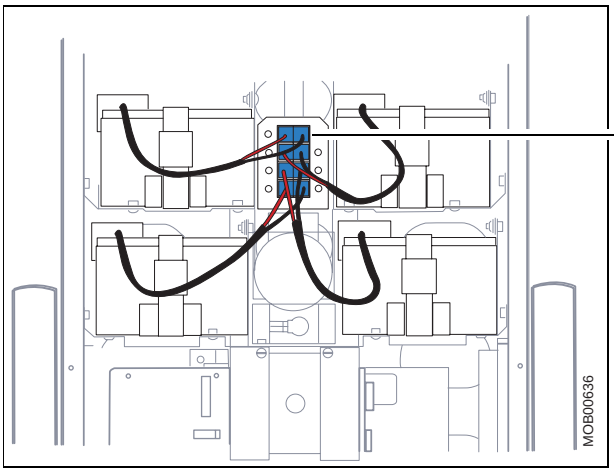



Fig. 3

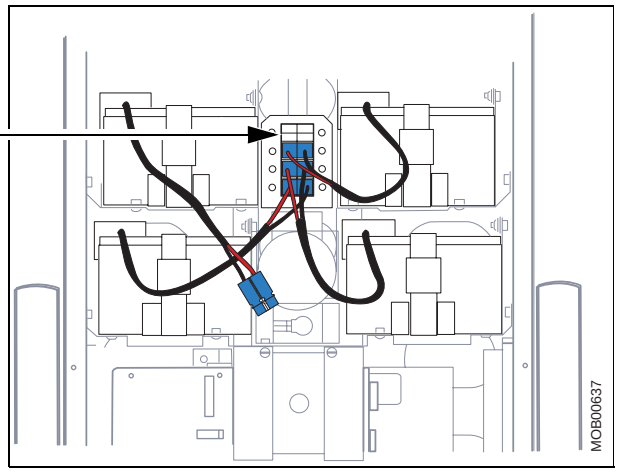



Fig. 4

- Disconnect the batteries by removing one of the KBATT plugs (Fig. 3 and Fig. 4).
- Measure the residual voltage at test points CAPPOS and CAPNEG on board D7 (Fig. 2). The voltage measured must be less than 2 VDC.

**⚠WARNING**

**If the voltage measured between CAPPOS and CAPNEG is 0 V, the measurement device could be defective or the wires between the CAPPOS and CAPNEG test points on the capacitor bank could be damaged.**

**The capacitors could still be charged.**

**In this case, proceed as follows:**

- Make sure that the correct measurement range is set on the measurement device.
- Connect the measurement device to CAPPOS and CAPNEG.
- Switch S10 off. Connect the mains cable and switch the system ON.
- Check whether the voltage increases.
- Switch the system OFF, disconnect the mains cable and switch S10 on.
- Check whether the voltage decreases.

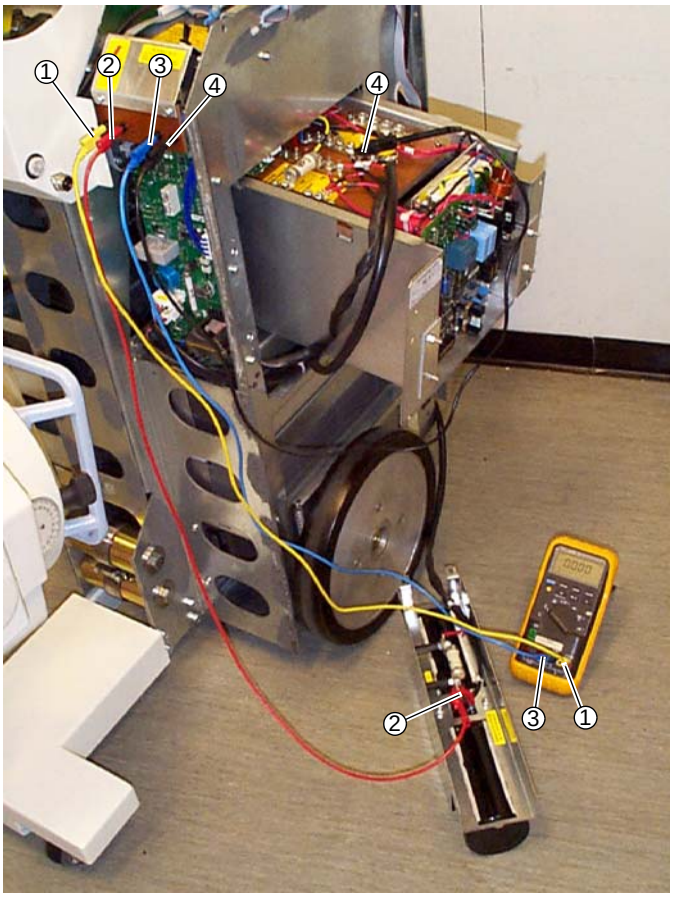
**⚠WARNING**

**If U11 or U301 is blown, the capacitor in M11 will not be discharged with S10.**

**The capacitors could still be charged.**

**Verify that U11 or U301 has not blown. The capacitor in M11 must then be discharged as stated below.**

- Measure the voltage on the capacitors in M11 and check that the voltage level is <2 V DC. If not, discharge the capacitors with R103 (Fig. 5).




① Left connector on D7 to the + connector of the digital multimeter
② Second left connector on D7 to the fuse-side (U11) next to the capacitor
③ Second right connector on D7 to the - connector (GND) of the digital multimeter
④ Right connector on D7 to the P11 connector on the power conversion unit (M10)

Fig. 5

**⚠WARNING**

**If the charging/discharging does not function, the power conversion unit M10 and M11 must be considered “charged”.**

**This means a risk of high voltage.**

**Use caution when performing measurements at the capacitors in M10 and M11.**
**Use only the specified measurement devices (350 V DC).**

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **Err 3*** | During exposure | Interrupted expo-sure because of overvoltage > 142 kV | Only with "Err 3".<br>• Check the filament heating value for the selected kV (see section "P07 - Read-out filament values from battery backed RAM"). Compare the value with the value in the delivery protocol. If the difference is large, make a new adaptation (see section "P10 - Fast adaptation").<br>"Err 3" in combination with:<br>• "Err 21" & "Err 22". Check the measuring point "FIL_VAL" on D1 (see page 160** and page 110**).<br>• "CAL 13". Check the 60 V supply voltage on D4 (see page 160**). |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **Err 4*** | During exposure | Measured kV value deviates by more than 5 kV from the selected kV. | The deviation can depend on the adaptation.<br>• Measure the kV curve at measuring point "HTPEAK" (see page 140**). Compare the measured curve with the reference curve (see page 141**).<br>For a large deviation:<br>• Check the filament value (see section "P07 - Read-out filament values from battery backed RAM") and compare it with the values in the delivery protocol.<br>• If the difference is large a new adaptation is needed (see section "P10 - Fast adaptation")<br>• See also section "Error diagnosis HT and single tank".<br>• Check the connection K9 between D1 and H1 (single tank) and the connection between D1 and D13 (K8) (see page 140**) |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **Err 5*** | During exposure | No X-ray tube current. The measured tube current < 5 mA ("MAPOS" < 50 mV). | The check starts 0.8 ms after the exposure is started and ends at the end of the exposure. If an error occurs, the exposure is normally interrupted earlier by "Err 3" or "Err 23".<br>• Fault in the booster board.<br>If the message occurs in connection with service or maintenance on the generator, a defective connection may be the cause.<br>• Check the connections K64/1 and K64/2 on D13 and the K64 connection to the single tank (see page 140**).<br>• Check cables K9 and K8 (see page 140**).<br>• Check main fuse U101 (see page 140**).<br>• Check the trigger pulses INV A and INV B to the inverter, page 140**.<br>• Check the capacitance in the capacitor bank (see section "P03 - Capacitor bank and charging test").<br>• Check the current to the single tank and compare it with the curves in section "Error diagnosis HT and single tank".<br>• Check the connection to the booster board. |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **Err 6** | During preparation or exposure | The rotating anode frequency cannot be maintained above 142 Hz. | At preparation: The anode is accelerated for 2 s, the speed is measured. If the rotation is too slow, the acceleration phase is repeated and retested. If the rotation is still too slow or the anode looses speed too fast, a message will be displayed.<br>Remove K64 (page 140**) during the next test.<br>• Activate the radiation release switch to the first level (preparation) and listen for the anode to start up (see page 150**).<br>• Check that the following supply voltages are present on D4, +100 V, +15 V, +5 V DC (see page 150**).<br>• Check that the trigger pulses are present at "ROT"; when the anode is accelerated (see page 150**).<br>• Check that the measuring signals "ROT_VAL" on D4 and "ROT" on D1 are OK (see page 150**).<br>• Turn off the unit and remove K61. Measure the stator winding in the power plug.<br>➪ K61: 3-2 = 8 Ω<br>➪ K61: 1-2 = 5 Ω |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Displayed messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **CAL 7** | During exposure | The exposure time has reached its maximum value. | The maximum exposure time is 4 s.<br>• The exposure is normally interrupted earlier by "Err 5".<br>• Check the capacitance in the capacitor bank (see section "P03 - Capacitor bank and charging test").<br>• Check the filament heating (see section "P01 - Filament test").<br>• Check the tube current in measuring point "MAPOS" on D1 (see pages 140 and 141).<br>• Check the current to the single tank (see section "Error diagnosis HT and single tank"). |
| **Err 9** | During exposure | When measuring the kV value, a large high tension asymmetry is detected. | Normally the kV value is symmetric around ground. The acceptable deviation is ± 19.5 kV. This corresponds to HTD 2.5 V± 0.5 V.<br>• Intermittent measurement cables or defective single tank.<br>• Check the measurement cable K9 between D1 and the single tank (see page 140**).<br>• Check the current to the single tank (see section "Error diagnosis HT and single tank").<br>• Measure the HTD signal on D1 and compare it with notes and curves on page 140 and 141**. |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Displayed messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **Use 10** | Generator ON. The message does not interrupt a running exposure. | The single tank temperature measured is > 50°C or < 8°C. | • The generator is overheated and must cool down or the generator was stored in a cold room and must warm up prior to use.<br>• Too high or too low ambient temperature.<br>• As soon as the single tank temperature is < 47°C, check the measurement circuit for the temperature (see page 140**), contact K9. |
| **CAL 12** | During preparation | Stored filament value is lost. | • Check the voltage in the backup battery (see page 110**). The battery should have a voltage > 2.8 V<br>• Check that the battery jumper is securely attached (see page 110**).<br>• Make a new adaptation (see section "P10 - Fast adaptation"). |
| **CAL 13** | Generator ON | The voltage supply (60 V DC) to the filament circuit is beyond its limit. | • Check fuse U6 on D8 (see page 160**).<br>• Check the filament supply voltage +60 V DC (see page 160**). |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **CAL 14** | Generator ON | The voltage in the capacitor bank exceeds 360 V. | • Check the voltage level in the capacitor bank (see page 130**). Measure at measuring points "CAPPOS" and "CAPNEG" on D7.<br>• Check if LED V12 on D7 is lit (see page 130**). Check all supply voltages on D7.<br>• If the voltage is close to 360 V it can depend on the charger on D7. If the transistor in the buck converter is short-circuited, the current will flow until fuse U8 on D8 blows. Replace the D7 charging unit. |
| **USE 15** | During preparation | The exposure switch has been in preparation position for longer than 20 s (max. preparation time is 10 s if FW version lower than V0.1H). | • The user has kept the exposure release switch in preparation position for longer than 20 s after the "Ready" indicator lights up (anode speed is correct).<br>• If the fault reoccurs, check the exposure release handle (see page 140**). |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **Err 16** | Generator ON | The capacitors are charging too rapidly (> 28 V/s) | • Check the capacitance in the capacitor bank (see section "P03 - Capacitor bank and charging test").<br>• If the capacitance is too low, the capacitors are disconnected. If there is an internal error in the capacitors, the whole row is disconnected by a fuse (see page 125** and section "Battery circuit and power transmission unit").<br>• If the error occurs after working on the capacitor bank, the internal residual voltage in the modules may have been too high when they were connected to each other. This may have caused the fuse to blow (see page 125**). |
| **Err 17** | Generator ON | The capacitors are charging too slowly (≤ 1.4 V/s) | • Check that S10 on D7 is switched off.<br>• If the error occurs after working on the capacitor bank, check the cabling and the connections to the capacitor bank (see page 125**).<br>• Check fuse U8 on D8 and fuse U1 on D7.<br>• Check the capacitance in the capacitor bank (see section "P03 - Capacitor bank and charging test").<br>• Internal short-circuiting in a capacitor or in the capacitor bank (see section "Battery circuit and power transmission unit"). |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **Err 18** | Generator ON The kV value changes via the kV+ or kV- button. | The change in voltage level in the capacitor bank takes too long (> 0.5 s/V). See also "Err 17". | • Check whether S10 on D7 is switched off.<br>• Check if any of the capacitors in the capacitor bank are defective. The output energy may be consumed by a defective capacitor (see section "Battery circuit and power transmission unit").<br>• Check the signals "CHARGE_HIGH", "DISCHARGE" and "CHARGE_LOW" (see page 130**). Check fuse U1 on D7, U5 and U8 on D8 and resistors R100 and R101. |
| **CAL 19** | Generator goes ON before the ready lamp glows. | The leakage current in the capacitor bank is too large. | The measurement is performed during charging at 150 V DC. Charging is interrupted for 5 s. If the voltage drops by more than 1.6 V, a message will be displayed. See also "Err 17".<br>• In cases where the generator has not been operated for several months, the leakage current in the capacitors will have increased. Use the formation program P06 (see section "P06 - Capacitor formation").<br>• If the unit was in regular use before the message occurred, the error may result from increased leakage current or a damaged capacitor (see section "Battery circuit and power transmission unit").<br>• Check the capacitance in the capacitor bank (see section "P03 - Capacitor bank and charging test" and page 130**). |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **USE 20** | During exposure | The exposure release switch was activated during the exposure.<br>The exposure is interrupted manually. | • The user activated the switch by mistake.<br>• There may be a defective contact in the exposure release cable/handle. Check the function in the exposure release handle and the connections k11 and k1 (see page 140**). |
| **Err 21** | Generator ON | The measured value of the standby filament current has exceeded the limit. | "FIL_VAL" on D1 must be between 0.16 and 2.5 V when the filament is in standby mode.<br>• Check the supply voltages on D4, +60 V, +15 V and +5 V (see page 160**).<br>• Check the pulses at measurement point "FIL" on D4 (see page 160**).<br>• Check the value in "FIL_VAL" on D1 (see page 160**).<br>• Check the connection between D4 and the filament transformer (see page 160**). |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **Err 22** | Preparation | The exposure/ preparation filament current is not stable. | If the exposure filament level is OK, it should stabilize within 3 s.<br>• Check the voltages on D4, +60 V, +15 V and +5 V (see page 160**).<br>• Check the connection between D4 and the filament transformer (K60) (see page 160**).<br>• Check the trigger pulses in measurement point "FIL" on D4 (see page 160**).<br>• Check the value in "FIL_VAL" on D1. The value must be stable in the standby filament. After change-over to preparation, the value should stabilize again.<br>• See also "P01 - Filament test". |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **Err 23** | During exposure | The HT inverter has been interrupted several times, e.g. by overcurrent. | When the HT inverter has been interrupted more than 3 times, the exposure will be interrupted.<br>• Faulty inverter/inverter control<br>• Check the inverter current (see sections "Error diagnosis HT and single tank", "P12 - Inverter and single tank test" and "P13 - Inverter test").<br>• The X-ray tube may have arced during the exposure. Tube arcs can occur if the first exposure after a long interval is an exposure with high kV values.<br>The unit has to be started with several exposures at high mAs values. The kV values selected should be increased from 40 kV to 133 kV.<br>See also section "Error diagnosis HT and single tank". |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **USE 24** | During exposure | The last selected kV and/or mAs value is lost. The value has been replaced with 40 kV and 0.5 mAs. | • The X-ray tube may have arced several times, which temporarily disrupted the control system.<br>• Check the voltage in the backup battery > 2.8 V (see page 110**).<br>• Check that the battery jumper is attached (see page 110**).<br>• If the error occurs repeatedly, the single tank must be inspected according to the section "kV and single tank error diagnosis". If the single tank is working properly and the backup battery with battery jumper are okay, replace D1 (see pages 110** and 140**). |
| **USE 25** | Generator ON | The calculated load of the anode target has been lost. | The value is lost from CMOS memory. See also CAL 31.<br>• Check all supply voltages on D1 (see page 110**).<br>• Check that the battery jumper is properly mounted and that the voltage in the backup battery is > 2.8 V (see page 110**).<br>• A tube arcing has caused a temporary disturbance of the control system.<br>• If the error occurs repeatedly, the single tank must be inspected according to the section "kV and single tank error diagnosis". If the single tank is working properly and the backup battery with battery jumper are okay, replace D1 (see pages 110** and 140**). |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **CAL 26** | Generator ON | The CMOS memory cannot be read or programmed. | • Check all supply voltages on D1 (see page 110**).<br>• Check the voltage in the backup battery (> 2.8 V) and the battery jumper (see page 110**).<br>• If all power supply voltages are present, the error is probably on D1.<br>If the message "CAL 26" occurs repeatedly or if the message can not be acknowledged by pressing kV+ or by switching the unit OFF and ON, replace D1. |
| **CAL 27** | Generator ON during startup | Error in ROM memory. Check sum is incorrect. | • Check that all supply voltages on D1 are present (see page 110**).<br>• The ROM containing the program is defective. Replace the software (IC's I72, I66 and I74) on D1 (see page 110**).<br>• If the error reoccurs after replacing I72, I66 and I74, replace D1. |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **CAL 28** | Generator ON during startup | An error was detected during program execution. The program is interrupted. | • Check that all supply voltages on D1 are present (see page 110**).<br>• If CAL 28 reoccurs or remains displayed, the ROM containing the program may be defective. Replace the software (IC's I72, I66 and I74) on D1 (see page 110**).<br>• If the error remains after replacing the software, replace D1.<br>• Enter the cause and the error message "CAL 28" in the service protocol. |
| **CAL 29** | Generator ON | The single tank has been connected incorrectly. | • The single tank is missing or the cable harness has been incorrectly connected.<br>• Check that connection K9 on D1 is connected.<br>• Check for possible damage in the main cable harness between D1 and the single tank. Measure K9: 13-4 and move the arm and single tank while the connections are being measured (see page 140**). If damage is detected, replace the main cable harness (both cables) (see section "Replacement of the arm cable harness"). |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **USE 30** | Generator ON | The portion of the CMOS memory where the customer kV and mAs limit values are stored has been erased. | • The pre-programmed values are replaced with MOBILETT standard values. See also "CAL 31".<br>• Check the supply voltage on D1 (see page 110**).<br>• Check that the voltage in the backup battery is > 2.8 V and that the battery jumper is connected (see page 110**).<br>• If the message appeared once, it may indicate a tube arc which has disturbed the system. If the "USE 30" message occurs repeatedly, the single tank must be checked according to Error diagnosis HT and single tank. If the function of the single tank is OK and "USE 30" occurs repeatedly, replace D1.<br>If necessary, reinstall the customer kV and mAs limit values (see sections "P14 - Number of kV steps and upper kV limit and P15 - Upper mAs limit"). |
| **CAL 31** | Generator ON | The voltage in the backup battery on D1 is below 2.8 V | • The battery life has expired.<br>• The battery jumper J1 on D1 is lost or has a bad connection.<br>• To change a battery (see section "Replacing the backup battery"). |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Dis-played messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **Err 32** | Service mode Test program P03 | The capacitance of the capacitor bank is too low. | • One or more capacitors are disconnected. If there is an internal error in the capacitors, the whole row is disconnected by a fuse (see page 125** and section "Battery circuit and power transmission unit").<br>• If the error occurs after working on the capacitor bank, the internal residual voltage in the modules may have been too high when they were connected to each other. This may have caused the fuse to blow (see page 125**). |
| **Err 33** The mes-sage is not displayed to the operator. | Generator ON | Temporary signal fault during program execution. | • "Err 33" messages can be ignored. This message can only be read out from the message history, P08. **The message is only used as an aid for software development.**<br>• Acknowledge and clear the mes-sage history. |
| **Err 34** | Generator ON | The number of mes-sages is beyond the maximum limit. | Messages are being lost and not dis-played for the customer. All mes-sages are stored in the error memory.<br>• Using section "P08 - Display of message protocol ", display and record the messages contained in the error memory. Using the error message list, try to determine which module, board, etc., is gene-rating the messages. |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Displayed messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **Err 35** | Generator ON | Temporary fault in the program execution, which was corrected by the "watch dog" | • Check the supply voltages on D1 (see page 110**).<br>• If the message appeared once, it may have been caused by a tube arc that disturbed program execution. If the message "Err 35" occurs repeatedly, the single tank must be checked according to "Error diagnosis HT and single tank". If the function of the single tank is OK and "Err 35" occurs repeatedly, replace D1. |
| **Err 36**<br>The message is not displayed to the operator. This message can only be read out from the message history, P08. | Generator ON | The inverter was interrupted once, e.g. by overcurrent. | If the inverter has been stopped more than 3 times, the exposure will be interrupted and the Err 23 message is shown on the display.<br>• Check the inverter current (see sections "Error diagnosis HT and single tank" and "P13 - Inverter test").<br>• The X-ray tube may have arced during the exposure. Tube arcs can occur if the first exposure after a long interval is an exposure with high kV values.<br>The unit has to be started with several exposures at high mAs values. The kV values selected should be increased from 40 kV to 133 kV.<br>See also "Error diagnosis HT and single tank". |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

| Displayed messages | Mode of operation | Cause | Possible reasons and advice |
|---|---|---|---|
| **Err 37** The message is not displayed to the operator. This message can only be read out from the message history, P08. | Generator ON | The error message history is lost. It is indicated with 0´s and "Err 37". | • Check the supply voltage on D1 (see page 110**).<br>• Check that the voltage in the backup battery is > 2.8 V and that the battery jumper is connected (see page 110**).<br>• If the message appeared once, a tube arc may have disturbed the program. If the "Err 37" occurs repeatedly, the single tank must be checked according to section "Error diagnosis HT and single tank". If the function of the single tank is OK and "USE 37" occurs repeatedly, replace D1. |
| **Err 38** The message is not displayed to the operator. This message can only be read out from the message history, P08. | Generator ON | The error statistics are lost. | See "Err 37". **If "Err 38" is the only message in the history memory, it will not be necessary to replace D1.** These statistics are only used in the factory. |
| **USE 39** | Generator ON during preparation | Battery voltage is too low. | • Batteries not charged.<br>• Defective batteries.<br>• Defective battery charger D201 (see section "Battery circuit and power transmission unit"). |
| PC NodE | | The switch S:1 on board D1 is set in the wrong position. | This mode is only used at the factory. To quit this mode, put switch S1:2 in the OFF position. |

* See section "Monitoring the kV and mA values"
** Wiring diagram X037E

Tab. 1

## Monitoring the kV and mA values

*** Note on Err 3, Err 4 and Err 5:**

Under the following conditions, the corresponding Err. message is signaled:

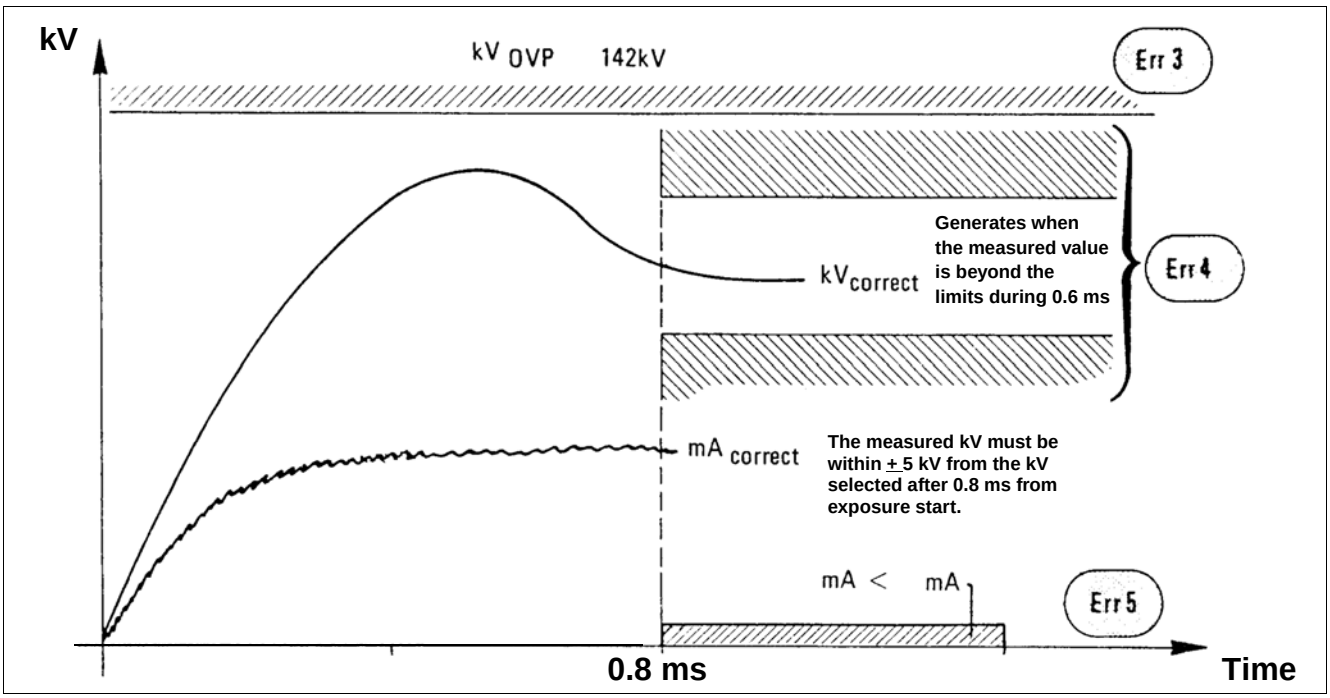

kV
kV OVP 142kV
Err 3
kV correct
Generates when the measured value is beyond the limits during 0.6 ms
Err 4
mA correct
The measured kV must be within ± 5 kV from the kV selected after 0.8 ms from exposure start.
mA < mA
Err 5
0.8 ms
Time

Fig. 1

**NOTE:** A change in the heating value may be due to the following causes:

1. Measurement error in the kV measuring circuit.
   a. Too high + $kV_{actual}$ value results in **increased** heating value (positive correction)
   b. Too low + $kV_{actual}$ value results in **decreased** heating value (negative correction)
2. Change in generator output.
   This may occur when exchanging the inverter or the single tank. In each case, the heating values must be readjusted and recorded (see P10 and P07 in the service program).
   a. If the generator output is increased, this results in an increase in heating value.
   b. If the generator output decreases, the heating value will be decreased.

Any change of the tube current involves a change in exposure time (mAs = i x t)!

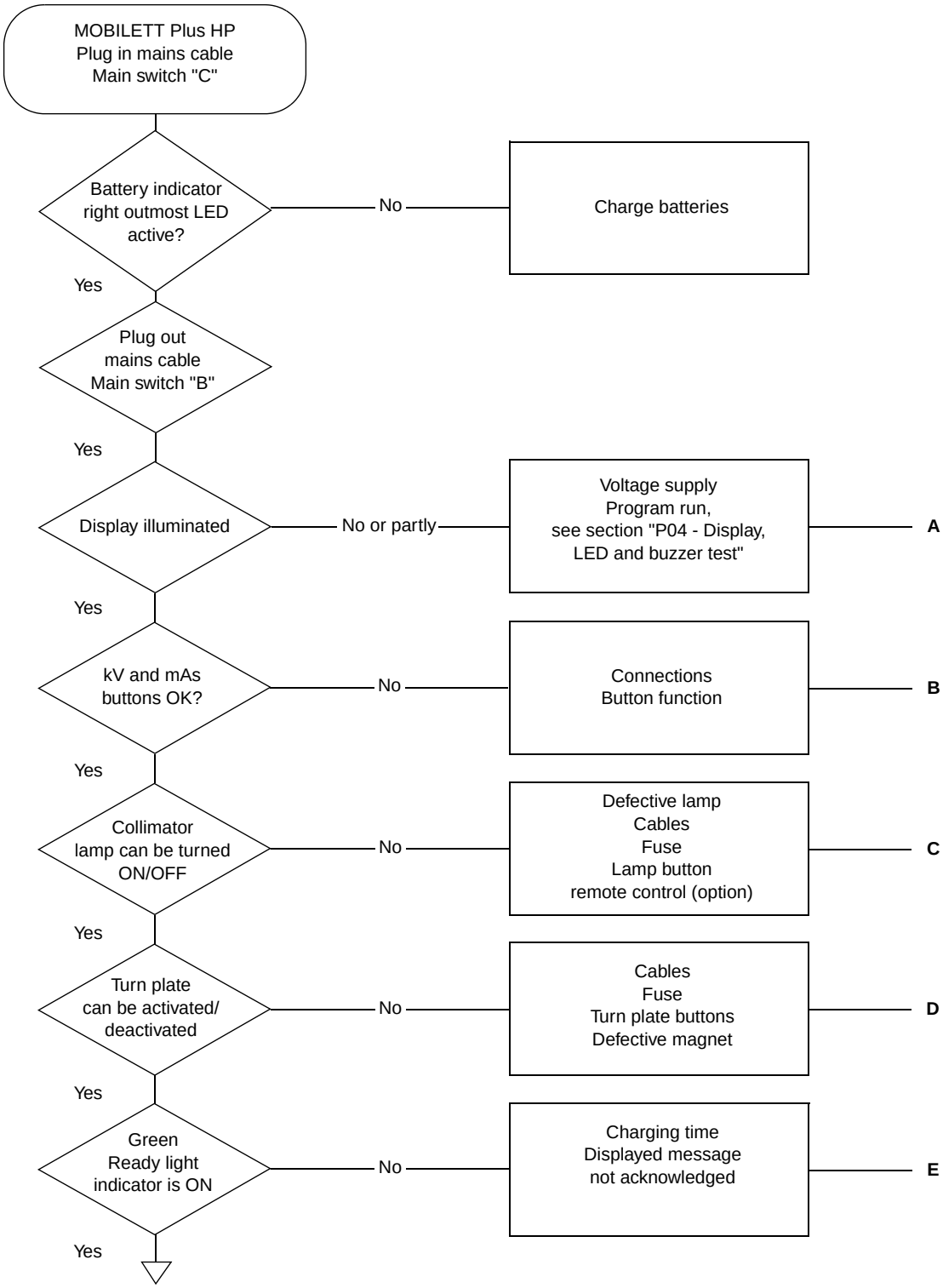
## List of displayed messages

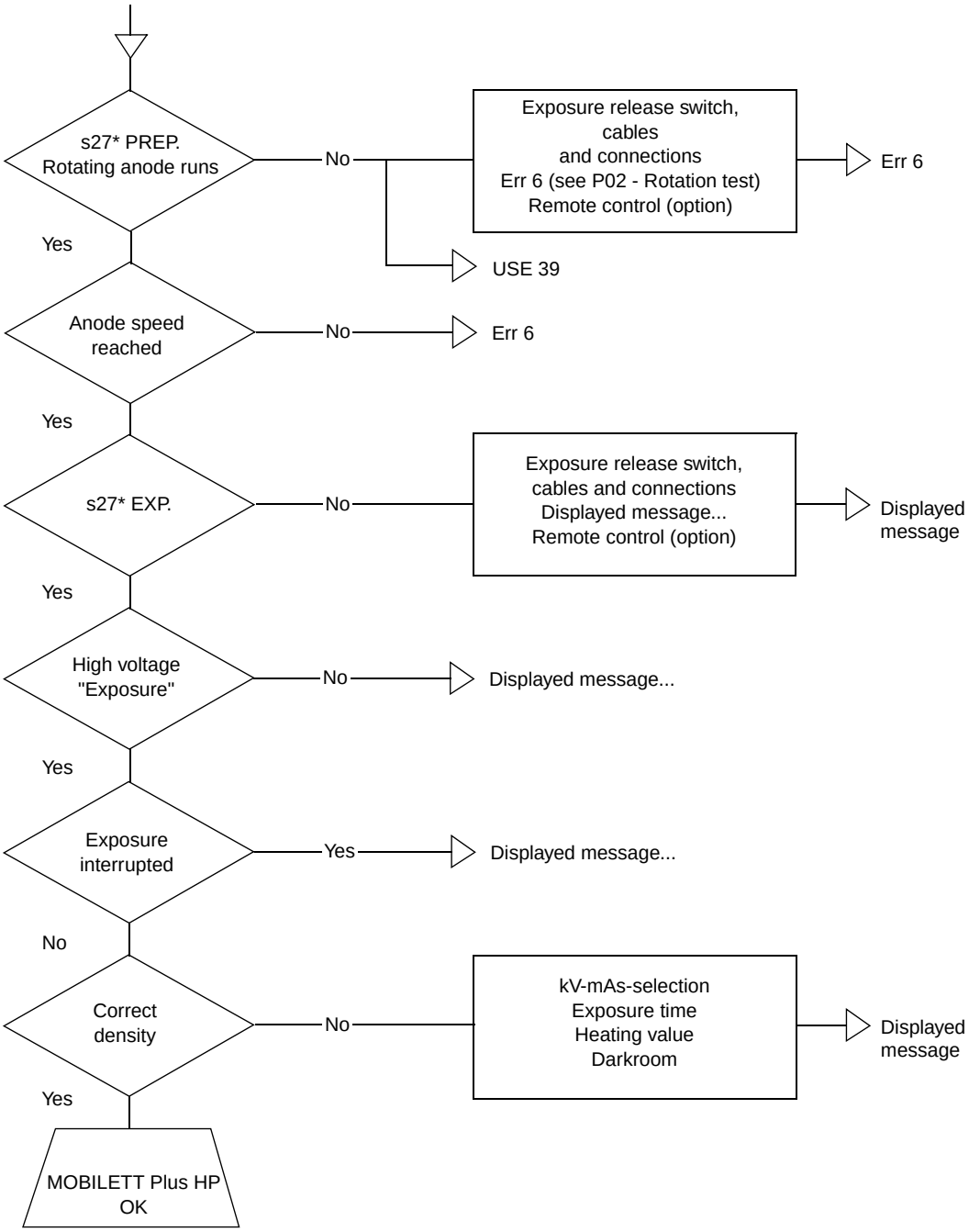
| | |
|---|---|
| Err 3 | Overvoltage > 142 kV |
| Err 4 | Poor kV regulation |
| Err 5 | No tube current |
| Err 6 | Anode speed too slow |
| CAL 7 | Exposure time too long |
| ___ | ___ |
| Err 9 | High-tension asymmetry |
| USE 10 | Single tank > 50° or < 8°C, measured at the location of the temperature sensor |
| ___ | ___ |
| CAL 12 | Values in CMOS memory lost |
| CAL 13 | Filament voltage, 60 V DC on D4 not present |
| CAL 14 | Overvoltage in the capacitor bank (> 360 V) |
| USE 15 | Preparation level held by the user > 20 s |
| Err 16 | Capacitor bank charging too fast |
| Err 17 | Capacitor bank charging too slow |
| Err 18 | Capacitor voltage charging too slowly |
| CAL 19 | Leakage current too high in the capacitor |
| USE 20 | Radiation release button was released during the exposure |
| Err 21 | Filament current incorrect for standby |
| Err 22 | Filament current incorrect for exposure |
| Err 23 | During exposure, the main inverter was interrupted > 3 times |
| USE 24 | The selected kV and mAs values are lost |
| USE 25 | The calculated anode load is lost |
| CAL 26 | Error in RAM |
| CAL 27 | Error in ROM |
| CAL 28 | Error in the operating system |
| CAL 29 | No single tank connected or an error in the connection |
| USE 30 | The customer values stored in CMOS memory are lost |
| CAL 31 | Replace backup battery < 2.8 V. |
| Err 32 | Capacitance of the capacitor bank is too low |
| Err 34 | Error log overfull |
| Err 35 | Watchdog responded |
| USE 39 | Battery voltage is too low |

## List of messages in the error memory

| | |
|---|---|
| Err 33 | Signal fault during program execution |
| Err 36 | Overcurrent in HT inverter |
| Err 37 | Error memory contents lost |
| Err 38 | Error statistics lost |

This chart shows the sequence beginning with the generator start through to exposure release and ends with the developed X-ray film. Potential errors are mentioned in the function box.
Additional hints that may be helpful during troubleshooting are listed under A-E in the section "Troubleshooting instructions".






* S27 is the exposure release switch. First step = PREP, second step = EXP.

**A**

- Look for a small red light to the right of the kV display. The light indicates that the program is in the startup phase.
- If there is neither a small red light nor text on the display, it indicates that the voltage supply is missing. Check the power supply D8 (see wiring diagram, page 20).
- Test the voltage supply to the CPU board and the display board (see wiring diagram X037E, pages 110 and 120).
- Check that all connectors on D8, D1 and D3 are connected.
- Check that the Reset LED on D1 is not lit (see circuit diagram on page 110, V33). If it lights continuously, there is an error on board D1.
- Check the voltage supply on D1 and D3. Refer to wiring diagram, page 110 and 120.

**B**

- Check button functions. Refer to the wiring diagram, page 120 and 180.

**C**

- Press the collimator lamp button and listen for a "click" from LR1 (see wiring diagram, page 180).
- If no "click" is heard, check the voltage supply on D4.
- Check the measuring point "LAMPON". If there is no signal, check k5, k9, k3 and k2.
- If a "click " is heard, check the voltage supply in the lamp bracket (see wiring diagram, page 180).

**D**

- Press the turn plate button and check if a "click" is heard from MR1 and MR2 (see wiring diagram, page 170). If a "click" is heard, check the voltage in K68:1-2 and compare it with the references given in the wiring diagram. Also check the resistance in the turn plate magnet (see wiring diagram, page 170).
  If no "click" is heard, check the voltage supply on D4 and measuring points "PIVOTON" and "PIVOTHOLD". If there are no signals, check k1, k5 and the buttons.

**E**

- After exposures with high mAs values, there is a delay for the ready light indicator until it lights again. The delay is to distribute the temperature in the anode target sufficiently and to allow time for the capacitor bank to charge.
  During startup, it can take up to 90 s before the ready light indicator lights up. A message will be displayed if the ready light indicator does not light.

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## Entering service mode

- Remove the upper system cover.

To activate the service program, adjust the switch to the service position (S1:1 ->ON, on board). This will display the program version:

kV mAs

**vEr x.x** = Version x.x (depends on the software version installed)

Exit the service mode by adjusting the switch to the operating position (S1:1 -> OFF on board D1). This will cause program execution to be aborted.

## Selecting test programs with the kV+/- buttons

There are 16 different test programs available. The display shows the program number in the kV window, the mAs display will be dark. Example, program 12:

kV mAs

**P12**

Pressing the "kV+" button will display the next test program. When the last test program is displayed, pressing the "kV+" button will show the program version again and so on. Pressing the "kV-" button will display the previous test program. The lamp button has a toggling function and is used both to start and stop the displayed test program. For example, after the lamp button has been pressed, the formation of the capacitor bank starts and the following is shown on the display:

kV mAs

**Ht tESt** = High tension test

The test program can be stopped by pressing the lamp button a second time. After the lamp button is pressed, the display shows:

kV mAs

**P12 StoP**

The program P12 has ended and a new service program can be selected with the kV+/-" buttons or P12 can be started with the lamp button.

## Error messages in service mode

Messages appearing in service mode, except in "Fast adaptation" are only displayed, they are not logged into the memory history.

## List of test programs available in service mode

### P01 - Filament test

(Wiring diagram, page 160)
At the beginning of the program, the tube is heated for 5 seconds in standby mode, followed by 12 seconds at high heating. During the test "FIL_VAL" is checked and must be stable and within the limits. During the test the display shows:

kV mAs

**FIL tESt** = Filament test

If an error is detected, the test program will be aborted. A beep will be audible and a message will be displayed:

kV mAs

P01 **Err 22** = Filament preparation error

P01 **Err 13** = Filament supply error

If the test ends successfully, the display will show:

kV mAs

**P01 PASS** = Filament test in program P01

Duration: Max. 20 seconds.

### P02 - Rotation test

(Wiring diagram, page 150)
Accelerate the anode with a 160 Hz frequency during two seconds. After this first acceleration, the speed is measured and if necessary, a second acceleration of two seconds occurs. When the correct speed is reached, the anode will rotate freely for 20 seconds or until the rotation frequency is below 142 Hz before it is braked during 9 seconds to a stop. An error message will be displayed after two unsuccessful attempts to accelerate the anode or if the anode looses speed too fast. When the test is activated, the display shows:

kV mAs

**Rot tESt** = Rotation test

After acceleration, the display shows the actual rotation frequency:

kV mAs

**Rot 143** = Rotation frequency 143 Hz: Normal value 158 Hz. Min. value 142 Hz.

If an error is detected, the test program will be aborted, a beep will be signaled and a message will be displayed:

kV mAs

**P02 Err 6** = Rotation error

If the test ends successfully, the display shows:

kV mAs

**P02 PASS** = Rotation test passed in program P02

### P03 - Capacitor bank and charging test

(Wiring diagram, page 130)
When the test is started the display will show:

kV mAs

**CAP tESt** = Capacitor test

During the test, the capacitor voltage is displayed except when the capacitance is shown. The capacitor will first be charged to 350 V, then discharged to 229 V.

kV mAs

**CAP 350** = 350 V

The voltage will be held for 5 seconds before it is restored to 350 V. During the test, the voltage in the capacitor bank is indicated, except when the capacitance is displayed:

kV mAs

**CAP 0.13 F** = Capacitance 0.13 Farad

If an error is detected, the test program will be aborted. A beep will be audible and a message will be displayed:

kV mAs

**P03 Err"xx"** = See actual "xx" in separate displayed message list

If the test ends successfully, the display will show:

kV mAs

**P03 PASS**

Duration: approx. 1.5 minutes.

### P04 - Display, LED and buzzer test

(Wiring diagram, page 120)
Both displays are dark when the test starts. Then the displays light up in sequence, beginning with the outermost character. The following characters are lit in the same way until all segments are on. The ready and exposure LED's light up in sequence and the test ends with an exposure beep. The sequence is repeated after a short time. When ending the test with the lamp button, the displays returns to P04 mode.

### P06 - Capacitor formation

(Wiring diagram, page 130)
This program is used only if the unit has not been operated for several months or if several capacitors have been replaced. The capacitors are slowly charged up to 353 V in a controlled sequence. The test program starts by displaying:

kV mAs

**CAP For** = Capacitor formation program

After a short time, the program displays the actual voltage in the capacitor bank:

kV mAs

**CAP 150** = 150 V.

The voltage value is increased approximately every six minutes. The charging sequence increases as follows:

150-250-299-325-337-345-348-351-353 V. At the 353 V level, charging will continue for another 48 minutes to decrease and stabilize the capacitors internal leakage current.
If an error is detected during the formation program, the program is aborted. When the program is aborted, there is a beep and a message is displayed:

kV mAs

**P06 Err"xx"** = See actual "xx" in separate message list

If the formation ends successfully, the display will show:

kV mAs

**P06 PASS** = Capacitor formation completed

Duration: approx. 100 minutes.

### P07 - Query filament values from the battery-backed RAM

The kV values are displayed in the "kV" field. The corresponding filament values are displayed in the "mAs" field. Pressing the "kV +" button will display the next higher kV and corresponding filament value and vice verse with "kV -".

The program starts at 40 kV in the table containing the filament values. The program shows only the selected number of kV steps.

The kV is changed in steps by briefly depressing the "kV + or kV -" buttons. By keeping the buttons pressed, the kV value will be continuously stepped up or down.

The generator filament values are self-adjusted to produce a kV value with minimum deviation. If the software has been optimized, a filament value for a specific kV value will have been indicated with the letter "A" in the extreme right position on the mAs display.

### P08 - Display the message history

The history contains two parts. The first is the appearance number and the second the actual message. The appearance number will be displayed in the "kV" field.

The corresponding message will be displayed in the "mAs" field. Pressing the "kV +" button will display the next higher number and corresponding message and vice verse with "kV -".

The program starts by showing the latest message in the history. If there are no messages the display will show:

kV mAs

**0** **Error** = Message history empty

The latest message has the highest number, for example:

kV mAs

**20** **CAL13** = There are total 20 new messages, number 20 is "CAL 13".

To exit P08, use the "lamp" button.

### P09 - Clear the message history

| NOTE | **When this program is run, the history will be cleared and the file will be empty. Use program P08 and record all messages before using program P09.** |
|---|---|

Activate the program with the "lamp" button. The display shows:

kV mAs

**P09 CLEAr**

To clear the message history, press the "mAs +" button for 5 seconds. The program confirms that the history is clear:

kV mAs

**0** **Error** = Message history empty

After the message clears, the program is ended.

### P10 - Fast adaptation

This program is used after replacing the single tank or if the memory loses the programmed values. The user must make a number of exposures.
The generator calculates and stores the optimized filament values for each kV value from these exposures.

After activating the program, the user must press the exposure button every time the ready light indicator lights. The program starts at a low kV value and when the actual value is stable, it increases to the next kV value automatically.

**Example**:

kV mAs

**40** **Ad Pr** = Generator in adaptation mode

During the adaptation, some messages may appear. Most of these can be ignored since the generator has incorrect filament values. However, check every message against the message list and confirm them by pressing the "kV +" button. When the generator is ready with an adaptation on a kV value, it continues to the next value. When the adaptation is finished, the program will stop and the display will show:

kV mAs

**P10** **PASS** = Adaptation program completed

### P11 - Backup battery test

(Wiring diagram, page 110)
After activating the program, it will display the battery voltage:

kV mAs

**bAt 3.2** = 3.2 V

When the battery voltage is <2.8 V, the battery needs to be replaced. Refer to the section "Replacement of backup battery". After 5 seconds, the program will be aborted. If the battery voltage is too low, there will be a message displayed with a message beep:

kV mAs

**P11 CAL 31**

If the battery voltage is OK, the display will show:

kV mAs

**P 11 PASS** = Battery OK

### P14 - Number of kV steps and upper kV limit

The program consists of two parts. The number of kV steps is selected in the first part and a kV limit is selected in the second part. When the first part is finished, the second starts automatically.

The first part, selecting the number of steps:
In this program, it is possible to choose between a fixed number of 25 or 49 steps. The number of steps corresponds to Siemens point scale with integer points or half integer. The factory setting is 25 steps. To change or check the valid setting, activate the program with the lamp button.

The display shows the selected number of kV steps, change with kV + or - buttons.

**Example:**

kV mAs

**25 StEPS** = 25 kV steps selected

Pressing the lamp button stores the currently displayed values and activates the second part.

The second part of P14 is the selection of the upper kV limit:
The display shows the selected highest available kV (min. 40 and max. 133 kV). This can be changed with the kV + or - buttons.

**Example:**

kV mAs

**133 SEt** = kV values up to 133 kV is allowed.

Pressing the lamp button stores the currently displayed values and also exits the program P14.

| NOTE | **Always check that the values selected correspond to the desired values after exiting the service program.** |
|---|---|

### P15 - Upper mAs limit

The program enables you to set the upper mAs limit. The available range is 0.5 - 360 mAs in battery operation. The maximum mAs value depends on the actual kV but can be additionally limited. When selecting an mAs limit value, all prior higher mAs values will be blocked and vice versa.

To change or check the highest available mAs, activate the program with the lamp button.

The display shows the selected mAs limit, change with mAs + or mAs - buttons.

**Example:**

kV mAs

**SEt** **100** = The mAs value is limited to 100 mAs

Press the lamp button to store the currently displayed values and to exit P15.

### P16 - Show the exposure counter

This program is activated by the lamp button and shows the actual number of exposures.

**Example: 1**

kV mAs

**599** = The number of exposures is 599.

**Example: 2**

kV mAs

**1** **15055** = The number of exposures is 115.055

Exit the program by pressing the lamp button.

| NOTICE | **The exposure counter can not be cleared via any of the service programs. The value is stored in the CMOS memory.**<br>**If the backup battery is depleted, the value could be lost.** |
|---|---|

## Tests and measurements in the high voltage circuit

- Connect the oscilloscope measurement cables to measuring points HTPOS and HTNEG or HT on D1.
- Adjust the trigger point to the falling edge of the high voltage curve and set the time to 20 - 50 ms/Div.
- If the high voltage cannot be displayed, check the tube current at measurement point MAPOS on D1. Check the inverter current with an external current transformer.
- Measure HTPOS and HTNEG on D1. Record the fall times (90 - 10% of HT), high voltage levels and whether the exposure was interrupted prematurely. Compare with Fig. 2 "HT and inverter current, inverter and single tank normal" .
- Measure the inverter current using an external current transformer and the HT. Compare with Fig. 1 "HTPEAK and inverter current, inverter and single tank normal" .
- In case of an error, compare the oscillogram with Fig. 1 "HTPEAK and inverter current, inverter and single tank normal" .

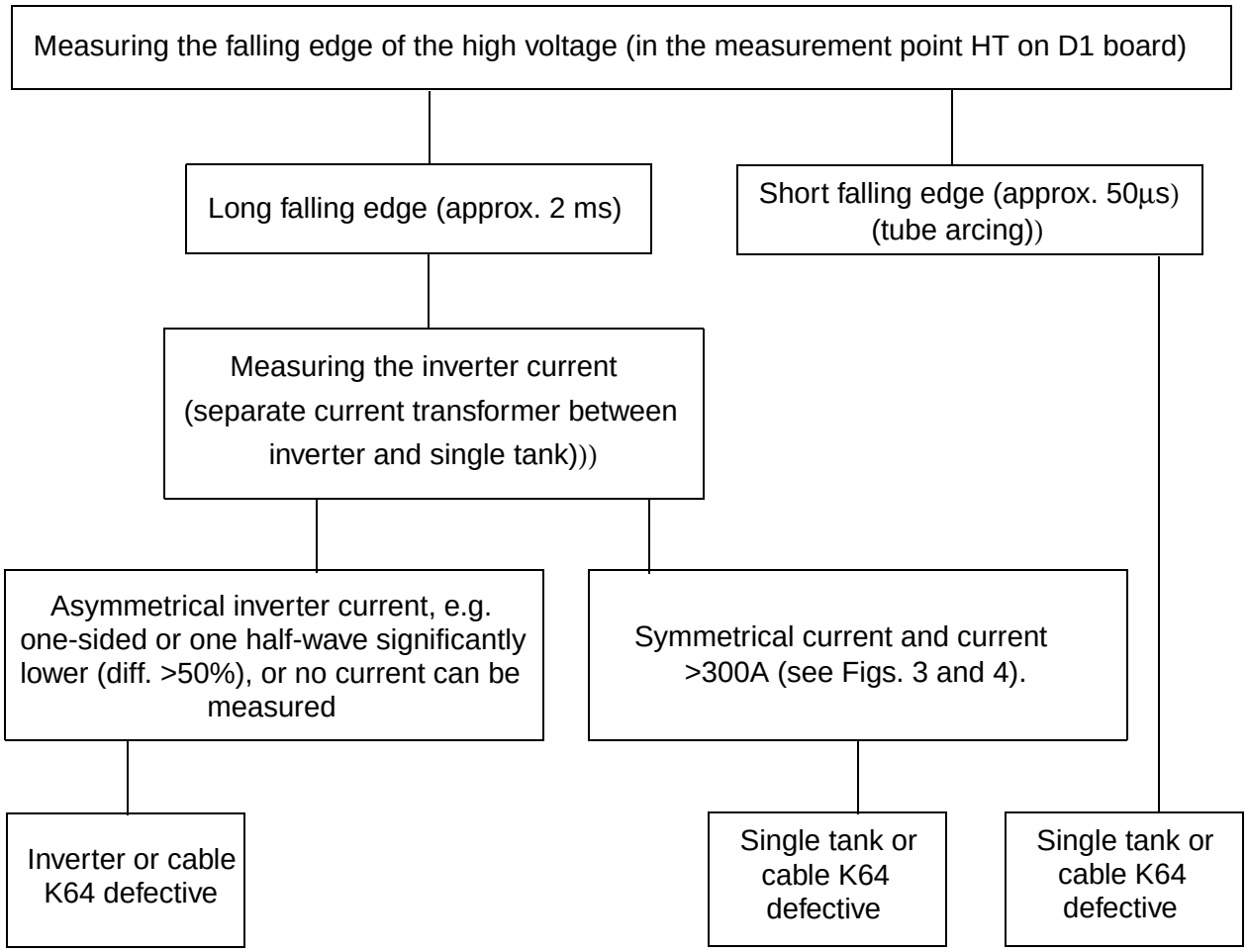
| NOTE | **The inverter current is always measured using a separate current transformer between the inverter and single tank.** |
|---|---|

## Malfunction in the inverter or single tank

The following procedure will help you to determine whether the problem is caused by the inverter or the single tank.

**The current flow between the inverter and the single tank must be approx. symmetrical. If this is not the case, the inverter is defective.**

Measure the resistance between K63/POS and K64/1 or K64/2 or K63/NEG and K64/1 or K64/2. The value must be larger than 0.5 Mohm. If the value is less than 100 ohms, the inverter is defective (transistors in the modules are defective).


Measuring the falling edge of the high voltage (in the measurement point HT on D1 board)
Long falling edge (approx. 2 ms)
Short falling edge (approx. 50µs) (tube arcing))
Measuring the inverter current (separate current transformer between inverter and single tank)))
Asymmetrical inverter current, e.g. one-sided or one half-wave significantly lower (diff. >50%), or no current can be measured
Symmetrical current and current >300A (see Figs. 3 and 4).
Inverter or cable K64 defective
Single tank or cable K64 defective
Single tank or cable K64 defective

**NOTE** **The inverter current is always measured using a separate current transformer between the inverter and single tank.**

**Overview**

| Faulty curve | Possible causes | What to do |
|---|---|---|
| Inverter current normal<br>HT+ discharges | Defective tube<br>Defective high voltage capacitor (+)<br>Arching to ground on plus side | Replace single tank |
| Inverter current normal<br>High speed HT - discharges<br><br>Fig. 7 and Fig. 8 | Defective tube<br>Defective high voltage capacitor (-)<br>Defective filament transformer<br>Defective insulation on the wires to the cathode<br>Arcing to ground on minus side | Replace single tank |
| Inverter current normal<br>High speed HT+ and HT- discharges<br><br>Fig. 6 | Defective tube<br>Defective high voltage capacitor (-)<br>Arcing between plus and minus side | Replace single tank |
| Abnormal inverter current; e.g. triangle shaped HT-discharges<br><br>Fig. 9 and Fig. 10 | Defective high voltage transformer<br>Defective diode strip<br>Defective tube | Replace single tank |
| Abnormal inverter current e.g. asymmetric<br><br>Fig. 10 | Defective inverter | Replace inverter |
| Very low tube current (normal inverter current) (Err 5) | Connection K64/1 and K64/2 reversed between D13 and single tank | Properly connect K64/1 and K64/2 |
| Full output voltage not obtained after adaptation | Defective high voltage transformer | Replace single tank |
| Rapid series of voltage peaks (increasing voltage) | Arcing in HT measurement resistor or series resistor | Replace single tank |

**Exposure values: 90 kV 2.0 mAs, "HTPEAK" 20 kV/div, Inverter current 100 A/div**

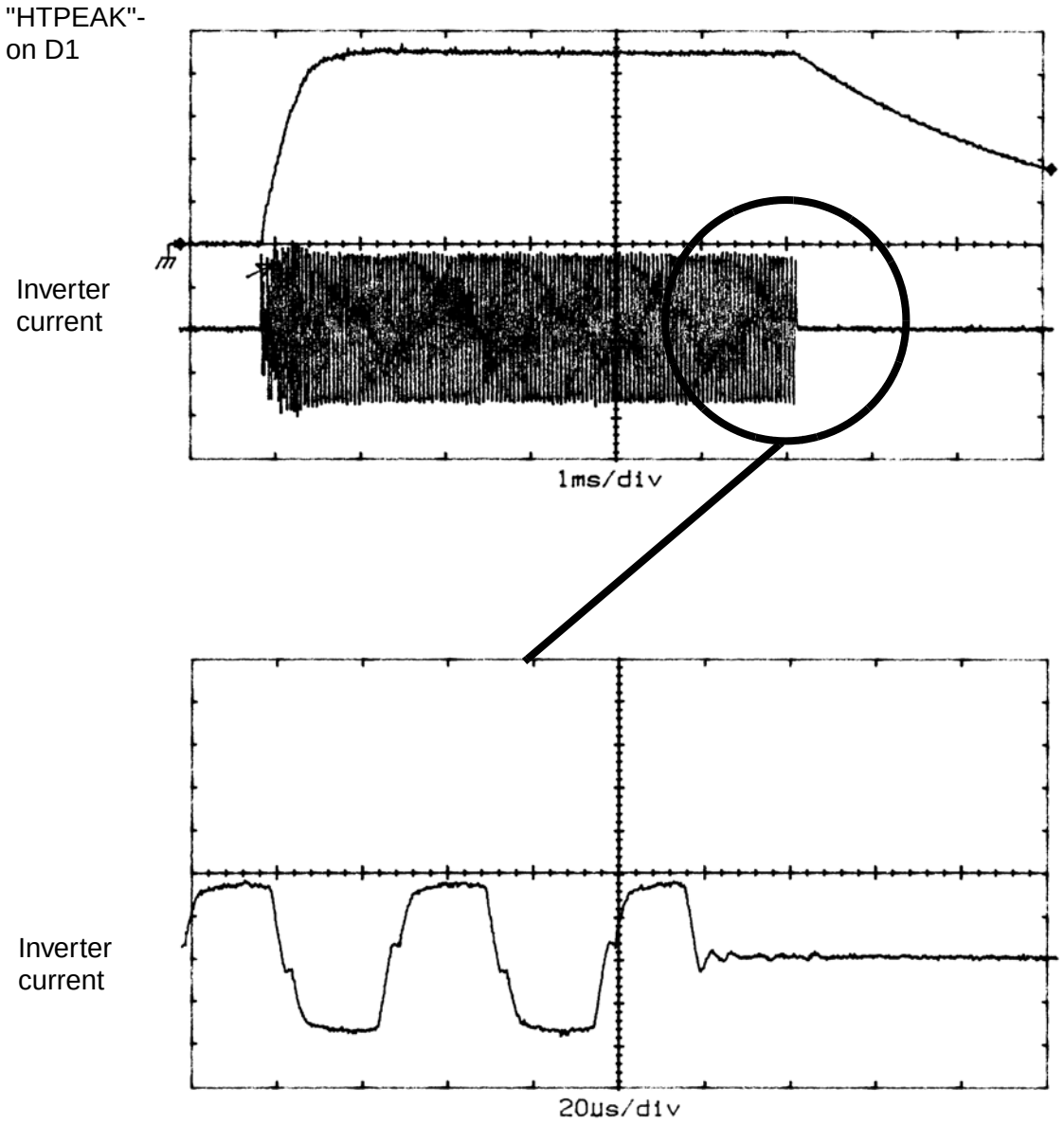



Fig. 1 HTPEAK and inverter current, inverter and single tank normal

**Exposure values: 40 kV 5 mAs, HT 8 kV/div (200 mV/div),**
**$I_{inverter\text{-}single\ tank}$ 100 A/div (only the end of the exposure is shown)**

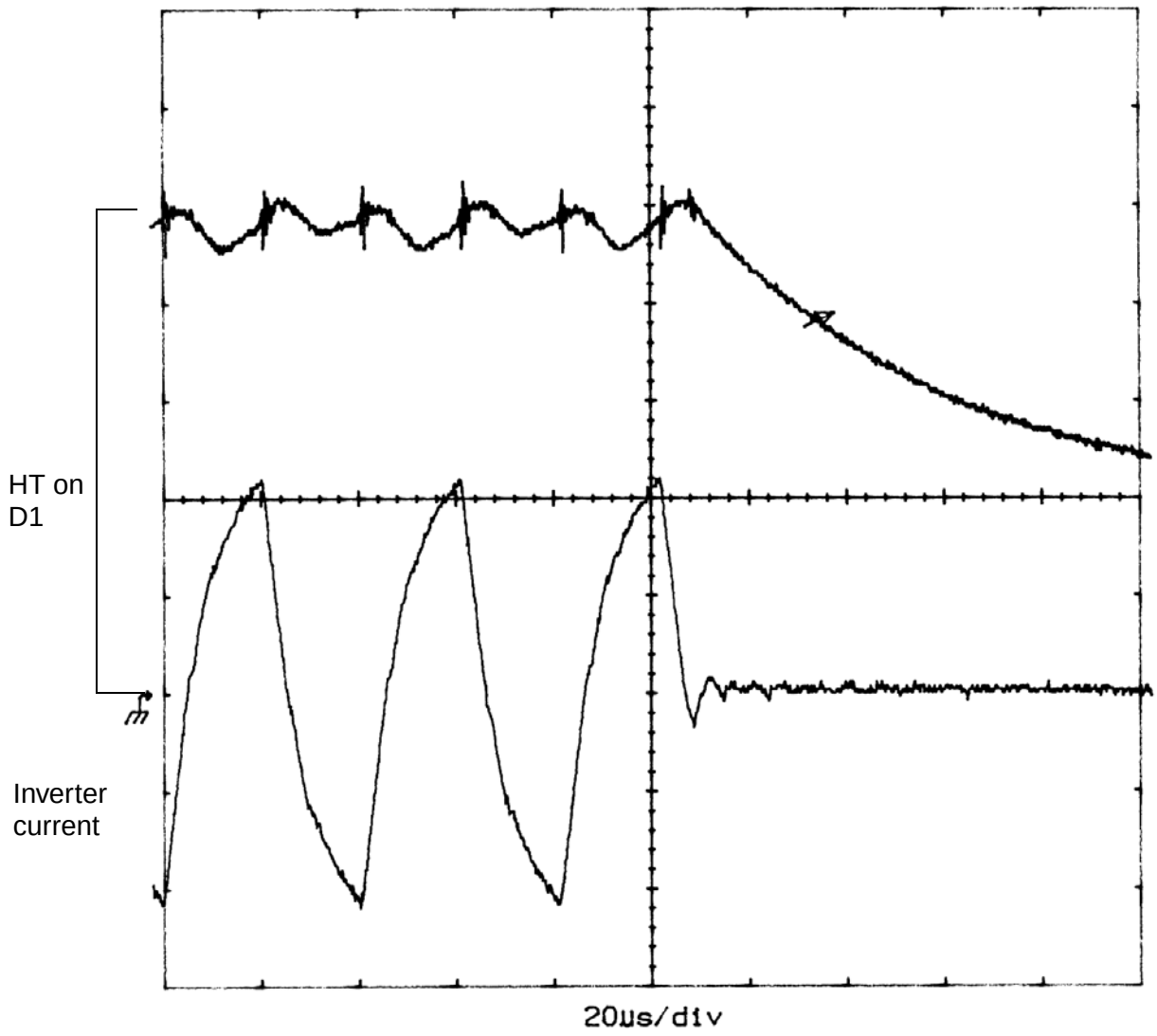



Fig. 2 HT and inverter current, inverter and single tank normal

**Exposure values: 90 kV 5 mAs, HT 20 kV/div (500 mV/div)**
**$I_{inverter\text{-}single\ tank}$ 50 A/div (only the end of the exposure is shown**

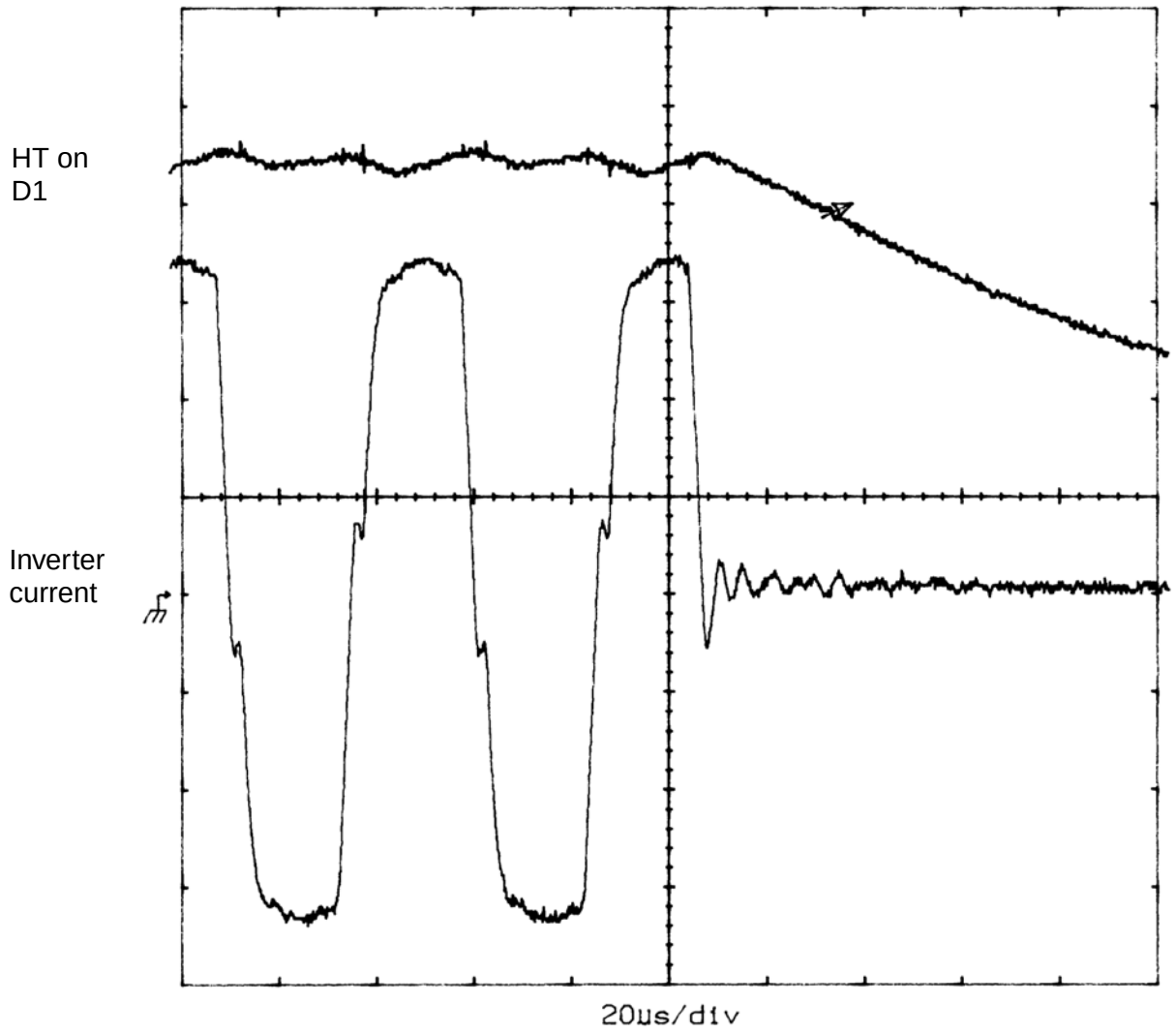



Fig. 3 HT and inverter current, inverter and single tank normal

**Exposure values: 33 kV 5 mAs, HT 40 kV/div (1 V/div),**
**$I_{inverter\text{-}single\ tank}$ 100 A/div (only the end of the exposure is shown)**

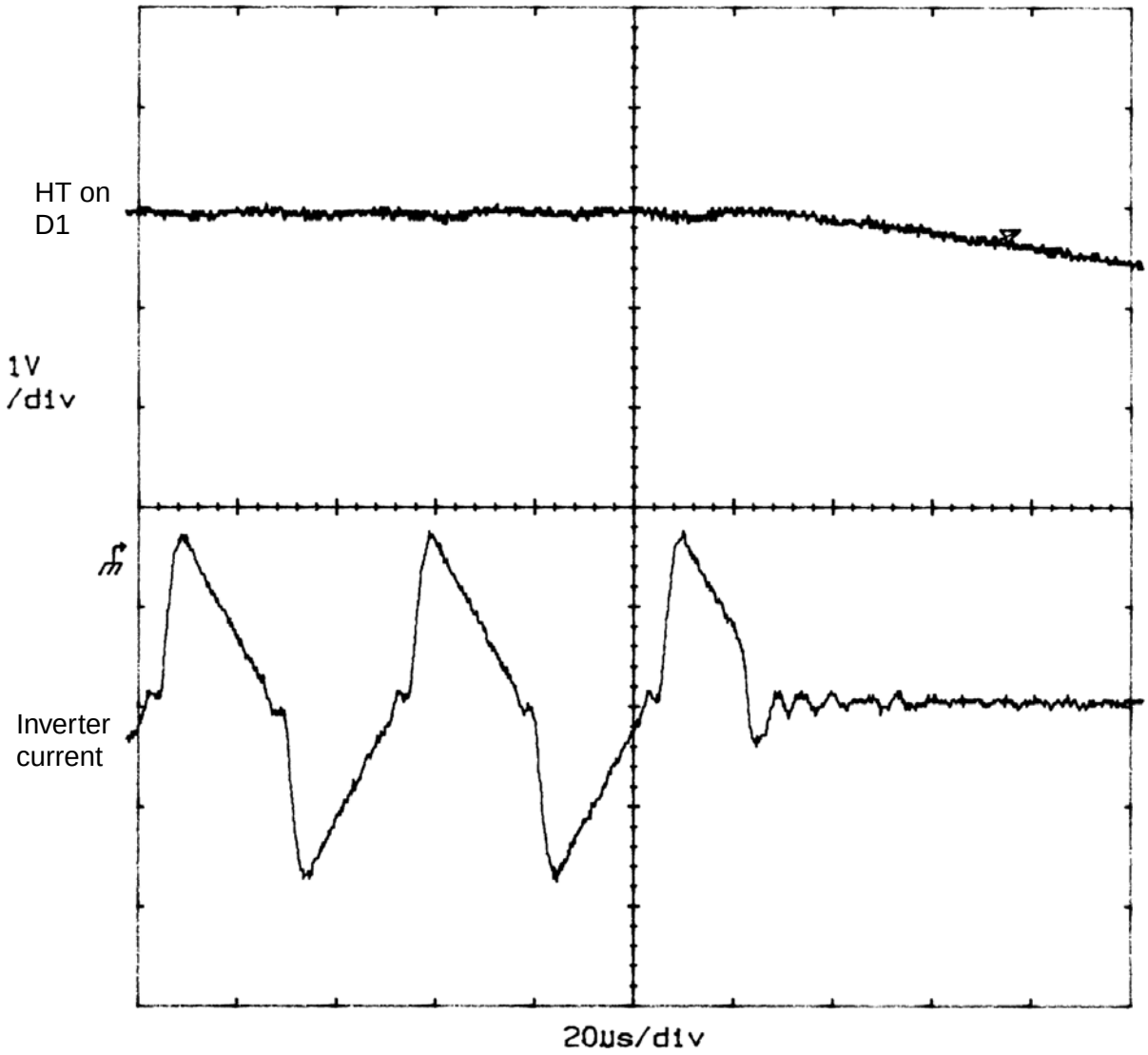



Fig. 4 HT and inverter current, inverter and single tank normal

**Exposure values: 133 kV 5 mAs, HTPOS & HTNEG 2 V/div,
20 kV/div, 200 µs/div (only the end of the exposure is shown)**

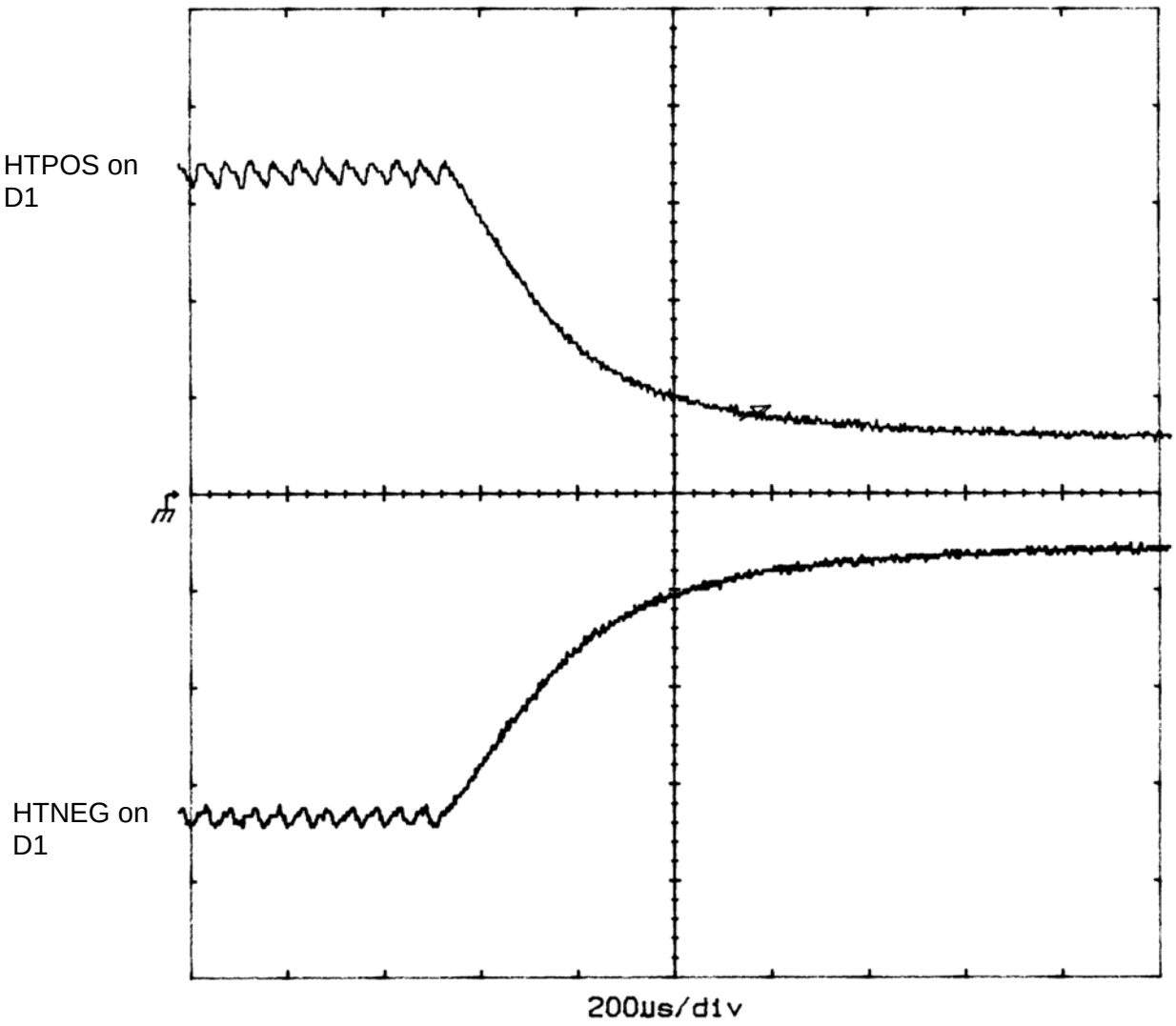



Fig. 5 HTsignal, inverter and single tank normal

**Exposure values, 133 kV 5 mAs, HTPOS & HTNEG 2 V/div,
20 kV/div; 200 µs/div (only the end of the exposure is shown)**

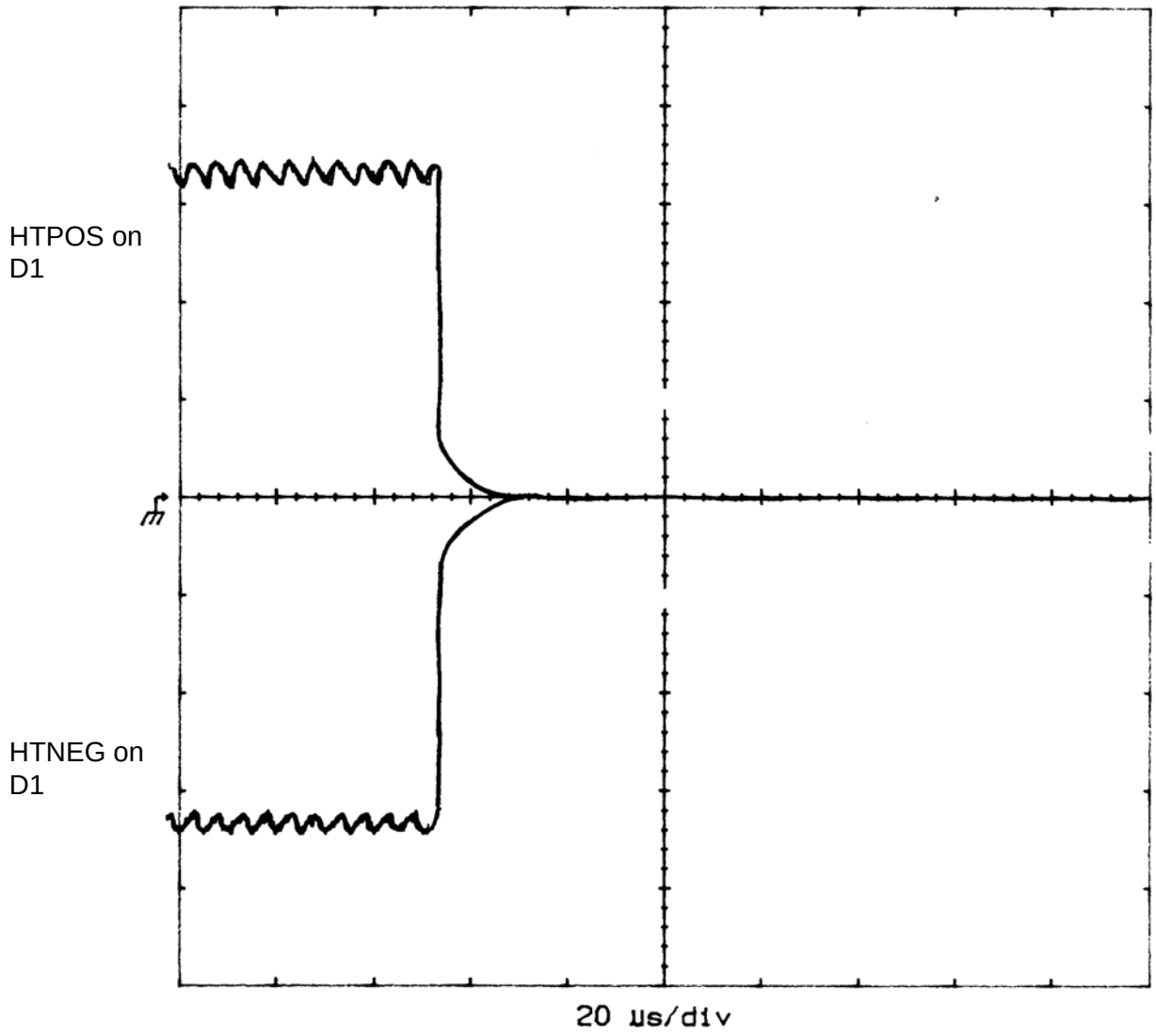



Fig. 6 HTsignal, arcing between plus and minus side (defective tube). Replace single tank.

**Exposure values: 133 kV 5 mAs, HTPOS & HTNEG 2 V/div, 20 kV/div; 100 µs/div (only the end of the exposure is shown)**

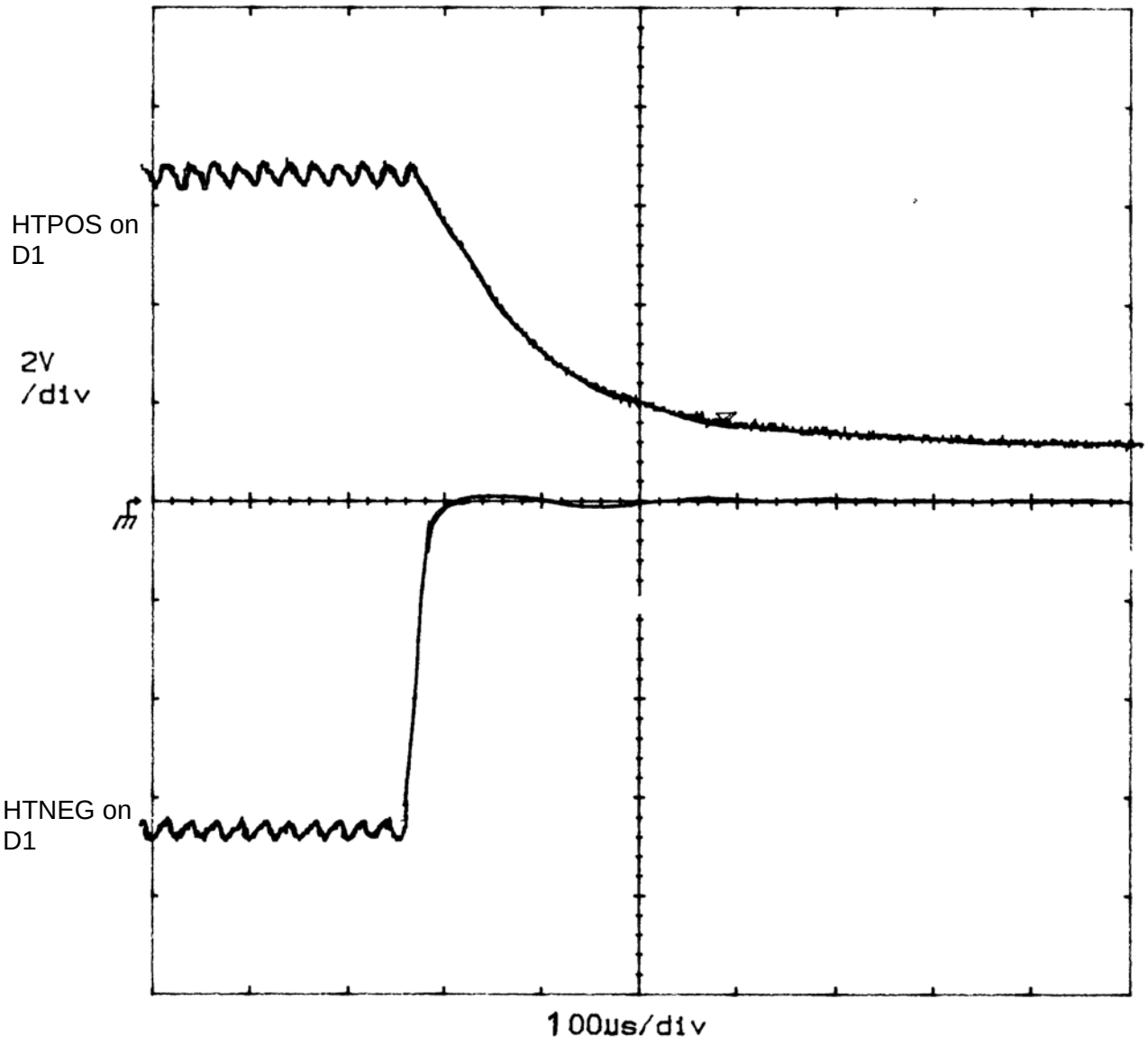



Fig. 7 HTsignal, high speed HTNEG discharges (defective tube, filament transformer, wires to the cathode).

**CH1: 20 mV/div, (100 A/div), 10 µs/div (inverter current);**
**CH2: 500 mV/div, 20 kV/div (HT)**

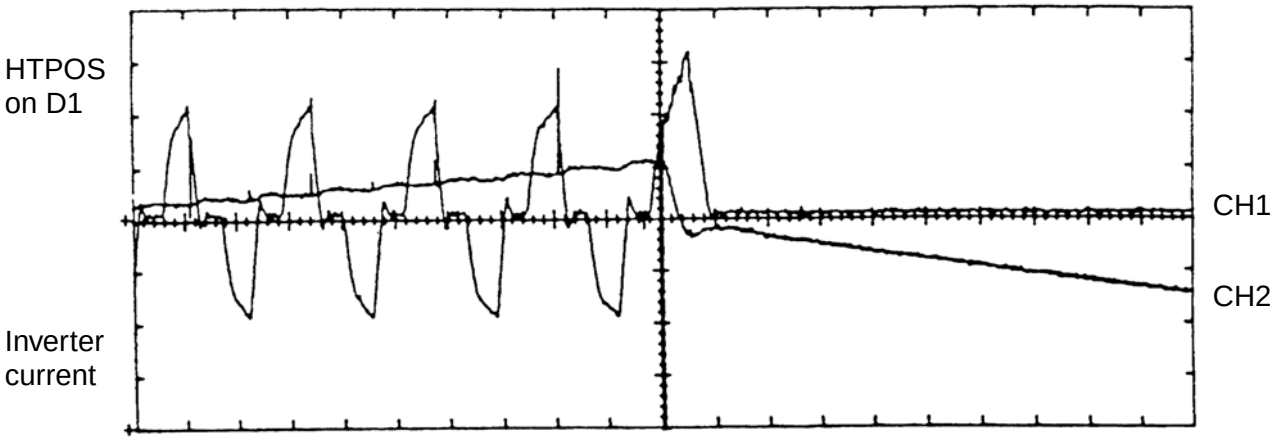



Fig. 8 High speed HT discharges (defective tube, transformer, capacitor)

**CH1: Inverter current 50 A/div, 10 µs/div**

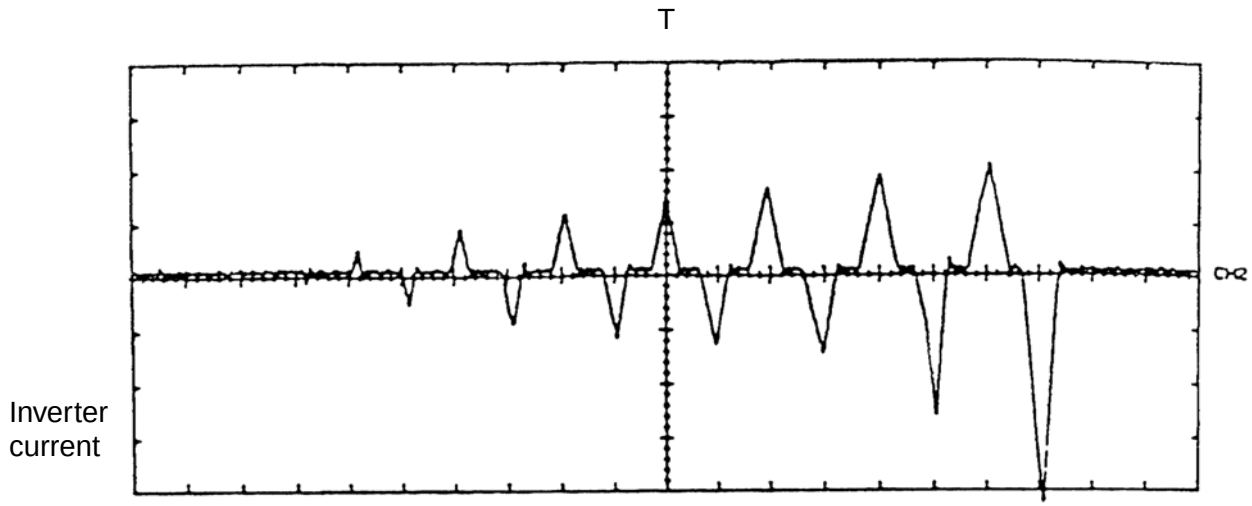



Fig. 9 Abnormal inverter current (defective single tank)

**CH1: Inverter current 50 A/div; 20 µs/div**

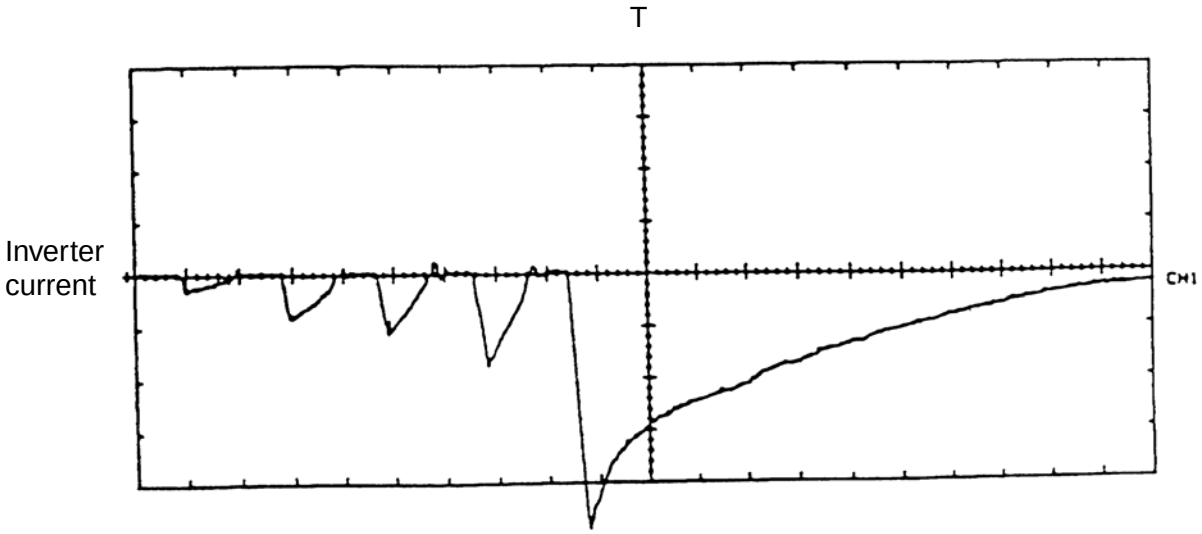



Fig. 10 Abnormal inverter current (defective inverter)

**CH1: I V/div, 40 kV/div, 20 µs/div (HT);**
**CH2: 100 A/div (inverter current)**

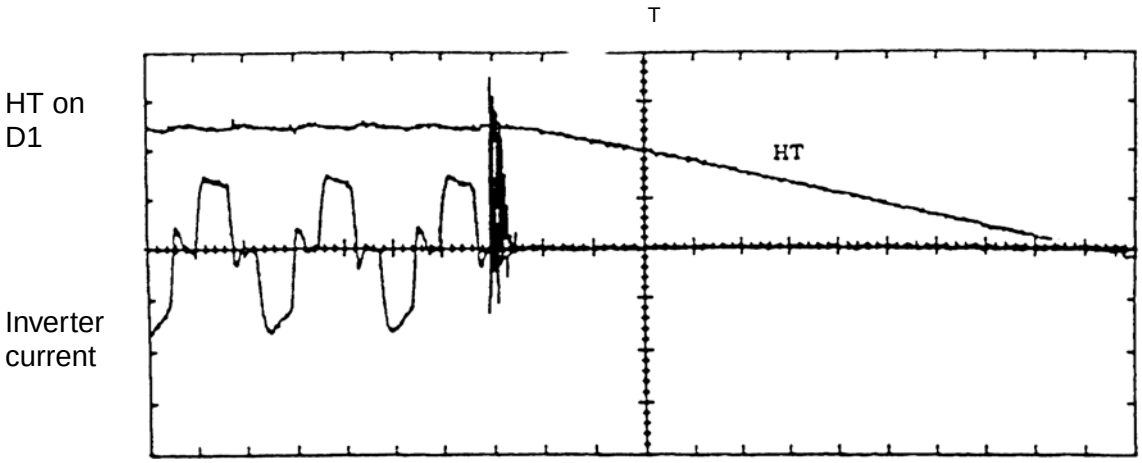



Fig. 11 Abnormal inverter current (defective inverter)

⚠DANGER

**High Voltage!**

**Life-threatening hazard of electric shock. Never work with the system open if the batteries are still connected and the capacitor is charged. If the batteries are connected, the complete system is powered on!**

**The capacitors in M10 and M11 may still be charged even if the system is switched OFF and the mains cable is disconnected. The capacitors in M10 and M11 must be considered charged until the protective measures listed in this section have been performed.**

NOTE

**The power conversion unit is also called power transmission unit in some documents.**

## Pull out power conversion unit, M10

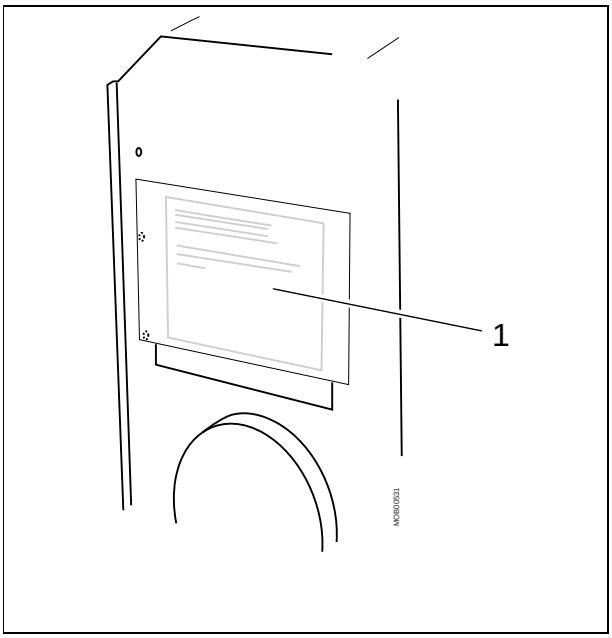



Fig. 1

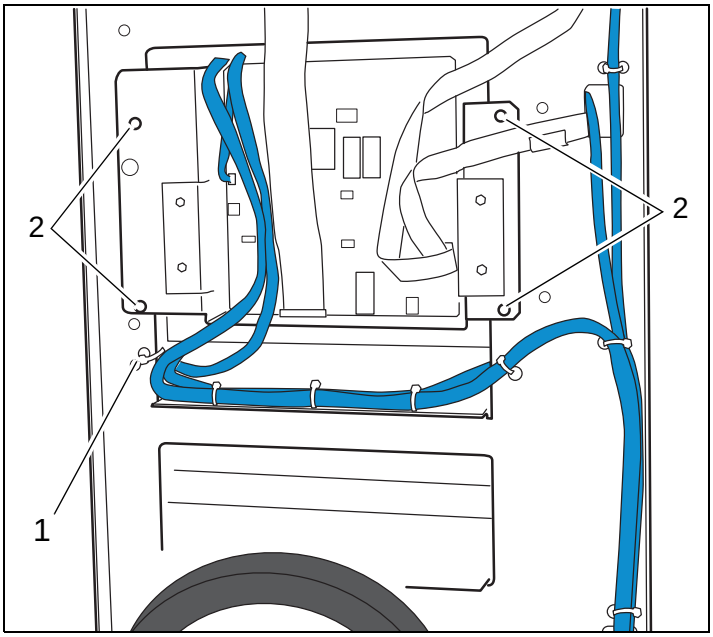



Fig. 2

- Remove left cover.
- Remove the cover with the warning sign (pos. 1 / Fig. 1).
- Disconnect K301/ K4A/ K4B/ K2 on D301.
- Remove cable tie (pos. 1 / Fig. 2).

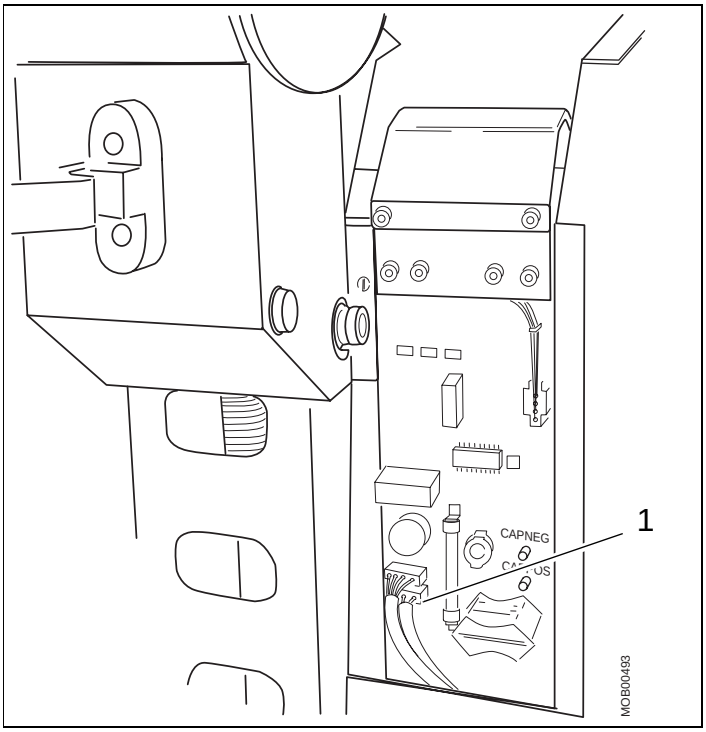



Fig. 3

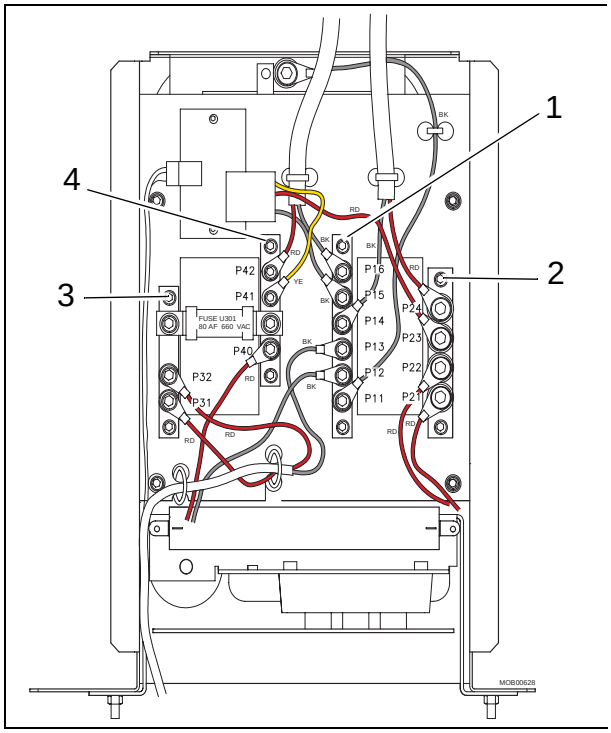



Fig. 4

- Disconnect K62 on D7 (pos. 1 / Fig. 3).
- Remove the four screws of the power conversion unit (pos. 2 / Fig. 2).
- Pull out power conversion unit (Fig. 4).

**⚠WARNING**

**Electric shock hazard!**

**Risk of physical injury.**

- **Check to ensure that there is no battery voltage (0V) between contact bar P1 and P2 (pos. 1 and pos. 2 / Fig. 4).**
- **Check to ensure that the capacitor voltage between contact bar P1 and P3 (pos. 1 and pos. 3 / Fig. 4) is < 2 V.**
- **Check to ensure that the capacitor voltage between contact bar P1 and P4 (pos. 1 and pos. 4 / Fig. 4) is < 2 V.**

- Remove the necessary cable ties and disconnect P14/ P24, P16/P42 and P11/P40 (see Fig. 4).
- Remove power conversion unit.

## Pull out capacitor bank, M11

- Remove the cover with the cassette compartment.
- Remove the warning sign placed in front of the batteries.

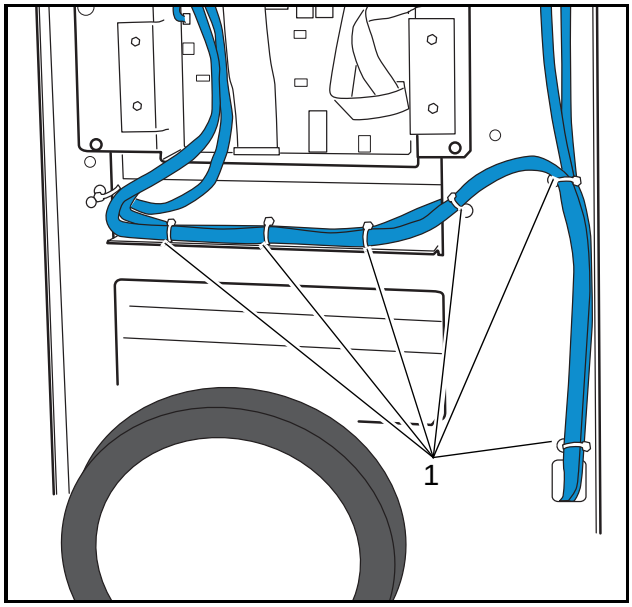



Fig. 5

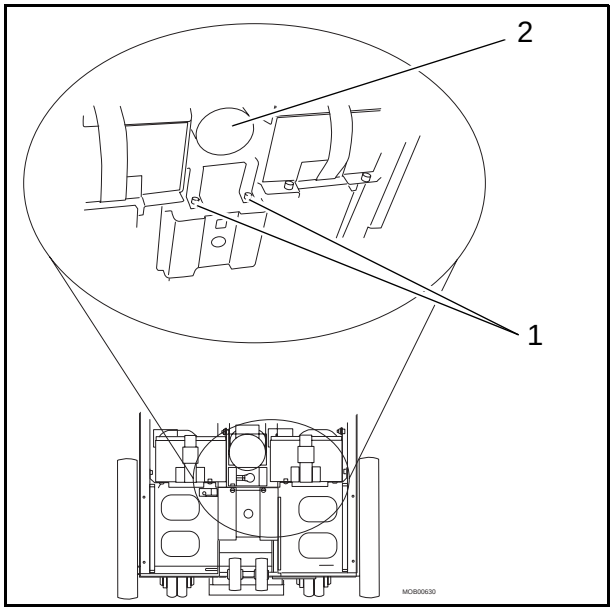



Fig. 6

- Remove the cable ties (pos. 1 / Fig. 5)
- Remove the two screws (pos. 1 / Fig. 6)
- Remove the capacitor bank, M11 (pos. 2 / Fig. 6).

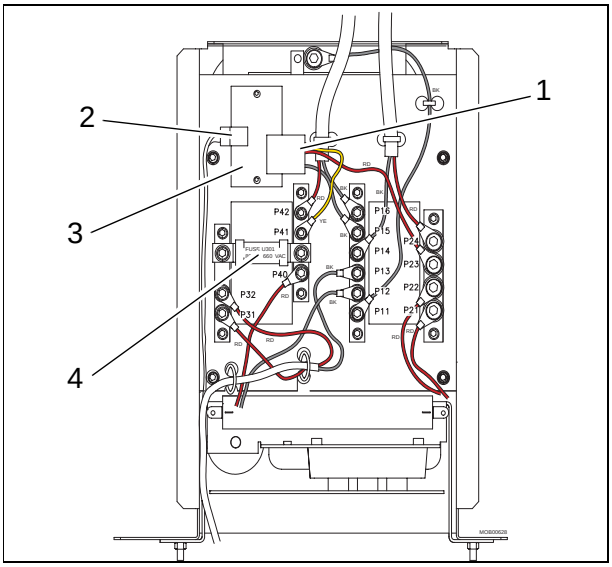



Fig. 7

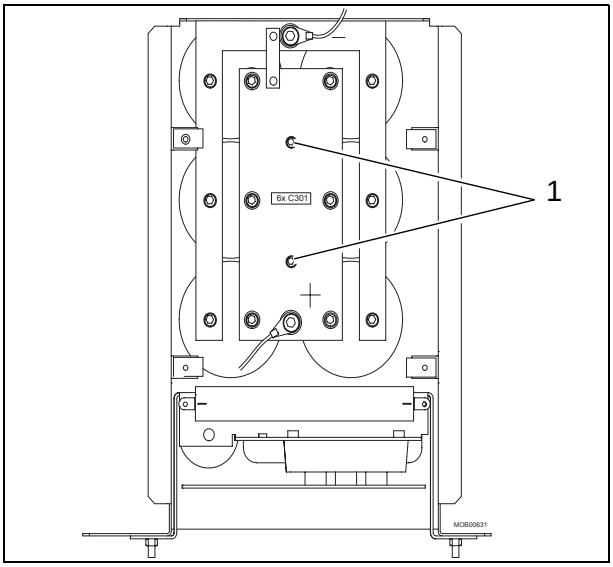



Fig. 8

## Exchange of voltage divider board D310

- Pull out power conversion unit
  (see section: "Pull out power conversion unit, M10" on Page 7 - 1).
- Disconnect K302/ K303 (pos. 1 and pos. 2 / Fig. 7).
- Replace D310 (pos. 3 / Fig. 7).

## Exchange of fuse U301

- Pull out power conversion unit
  (see section: "Pull out power conversion unit, M10" on Page 7 - 1).
- Make sure the capacitor units (both M10 and M11) are discharged.
- Replace U301 (pos. 4 / Fig. 7).

## Exchange of capacitors of M10

- Remove power conversion unit
  (see section:"Pull out power conversion unit, M10" on Page 7 - 1).
- Disconnect P31/ P11.
- Remove the four screws (two on each side) that keeps the connection plate.
- Remove the two screws in the middle (pos. 1 / Fig. 8) and remove the capacitor bank.

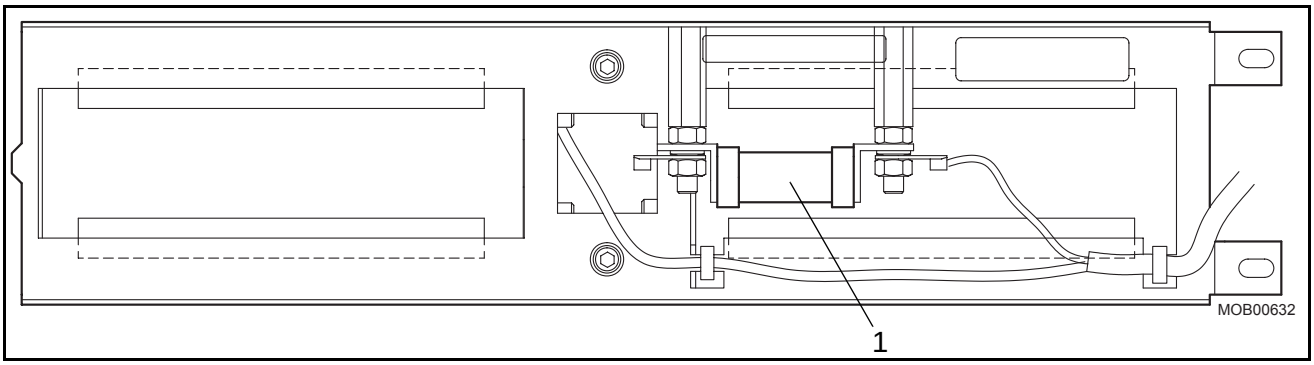



Fig. 9

## Exchange of fuse U11

- Pull out capacitor bank
  (see section: "Pull out capacitor bank, M11" on Page 7 - 3).
- Make sure the capacitor units (both M10 and M11) are discharged.
- Replace U11 (pos. 1 / Fig. 9).

## Exchange of capacitor bank M11

- Remove power conversion unit
  (see section: "Pull out power conversion unit, M10" on Page 7 - 1).
- Remove capacitor bank
  (see section: "Pull out capacitor bank, M11" on Page 7 - 3).

## Exchange of capacitors of M11

- Remove power conversion unit
  (see section:"Pull out power conversion unit, M10" on Page 7 - 1).
- Remove capacitor bank
  (see section:"Pull out capacitor bank, M11" on Page 7 - 3).

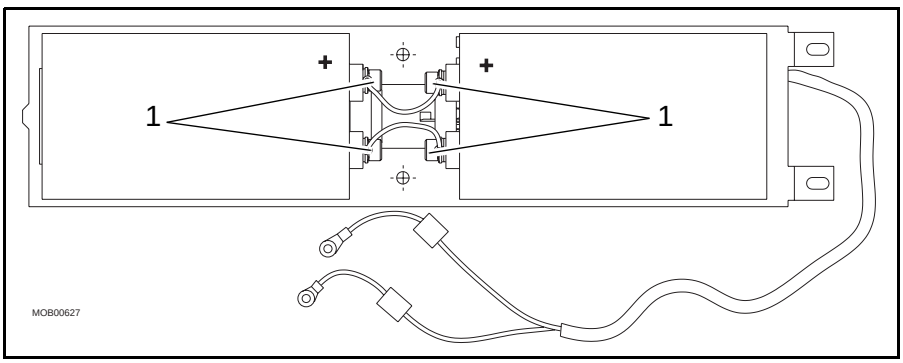



Fig. 10

- Remove the four screws (pos. 1 / Fig. 10).
- Exchange the capacitors C1 and C2.

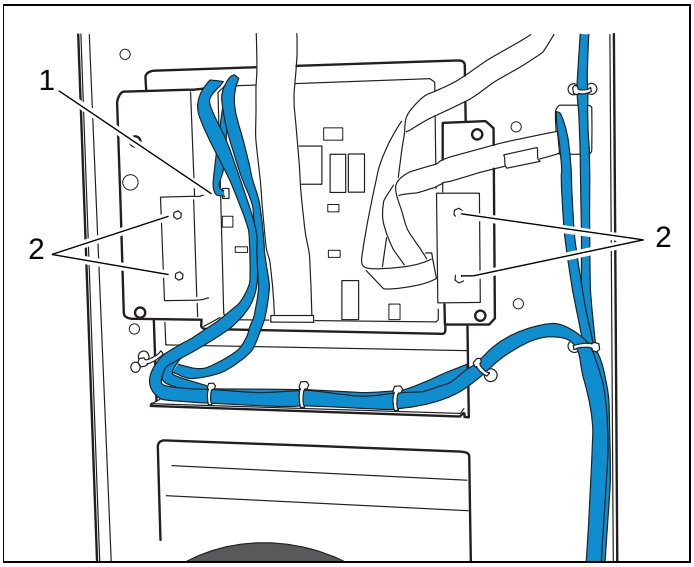



Fig. 11

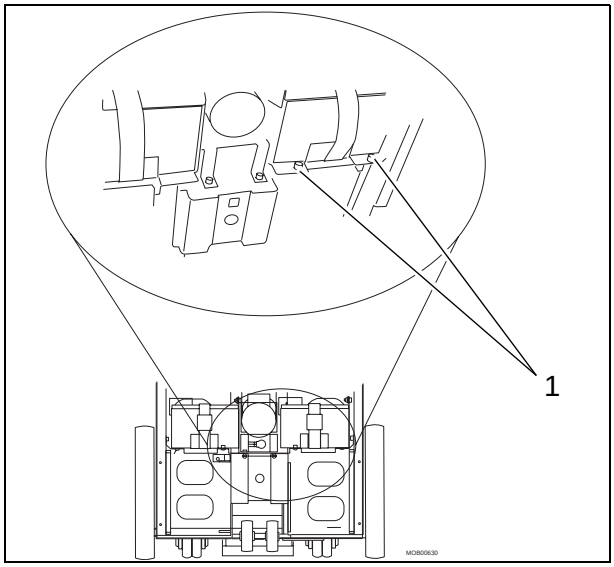



Fig. 12

## Exchange of booster assembly D301

- Remove power conversion unit (see section: "Pull out power conversion unit, M10" on Page 7 - 1).
- Disconnect P32/ P12/ P22/ P21.
- Disconnect K302 on D301 (pos. 1 / Fig. 11).
- Remove the four nuts (pos. 2 / Fig. 11).
- Replace booster assembly.

## Replacement of batteries B10

**NOTICE**

**For proper functioning, we recommend to replace all four battery banks at the same time.**

**Use Sonnenschein batteries, A512/10 S.**

- Check the terminal voltage of the new batteries with a digital multimeter. The terminal voltage should be at least 12.42 V.
- Remove the cover with the cassette compartment and the warning sign.
- Remove the two screws (pos. 1 / Fig. 12) from the battery bank you want to replace.
- Pull out the rail with the batteries and open the fastening strap.
- Replace the batteries.
- After remounting the covers, fully charge the batteries.

**⚠CAUTION**

**Incorrect treatment could decrease performance and battery life.**

**The new batteries must be fully charged before use.**

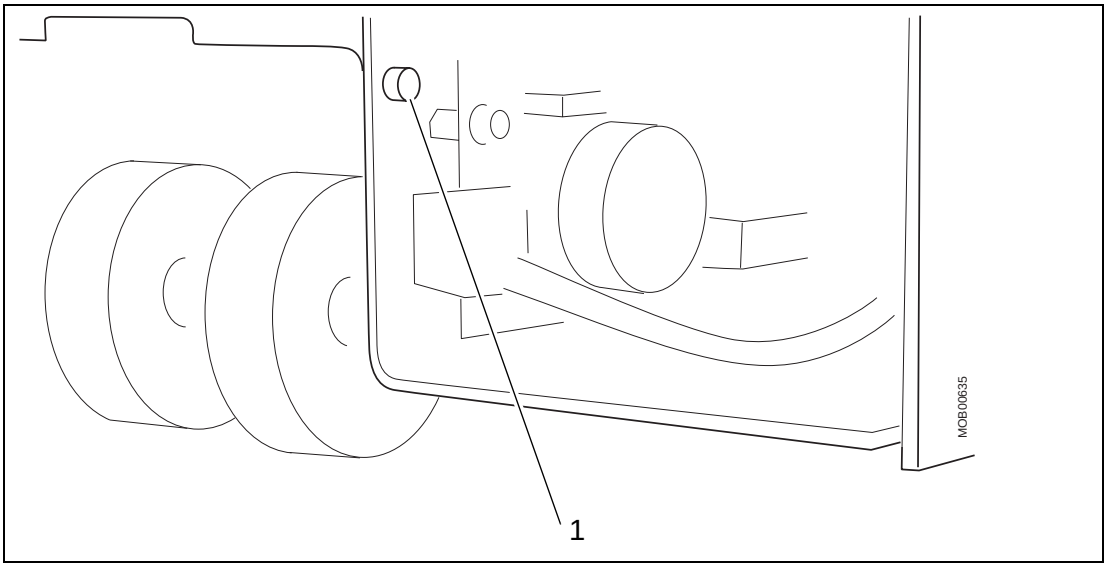



Fig. 13

## Replacement of battery charger board D201

- Remove the cover with the cassette compartment.
- Remove K201/ 202/ 203 on D201.
- Remove the front screw (pos. 1 / Fig. 13).

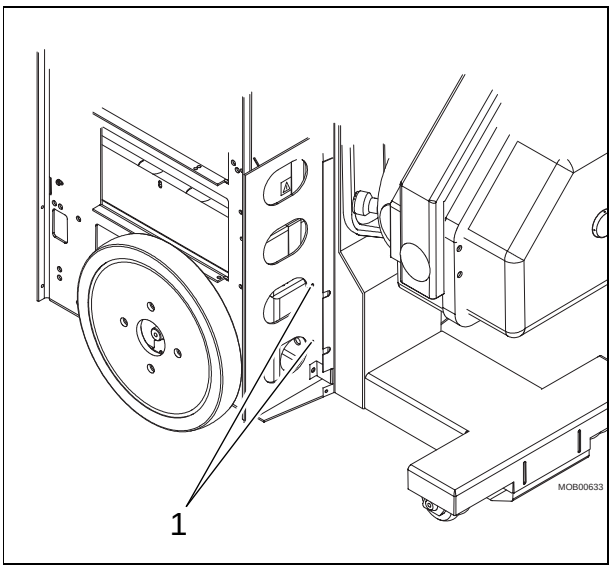



Fig. 14

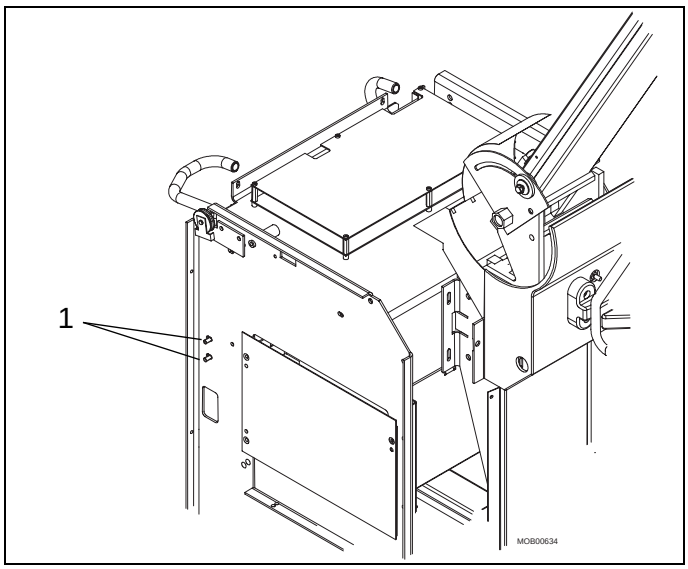



Fig. 15

- Remove the two back screws (pos. 1 / Fig. 14).

- Remove the board including the aluminium plate.

**NOTICE**

**If the MOBILETT Plus HP is equipped with the DAP measuring system (optional):**

**The power supply for the DAP measuring system must be disconnected during this procedure. Make sure to remember how the cables were connected, and if needed use the "Installation Instructions, DAP measuring system, SPR8-220.031.04..." for additional help.**

- Replace the board.

## Replacement of battery indicator D210

- Remove the right cover and the cover with the cassette compartment.
- Remove the two screws (pos. 1 / Fig. 15).
- Disconnect K203.
- Replace the battery indicator.

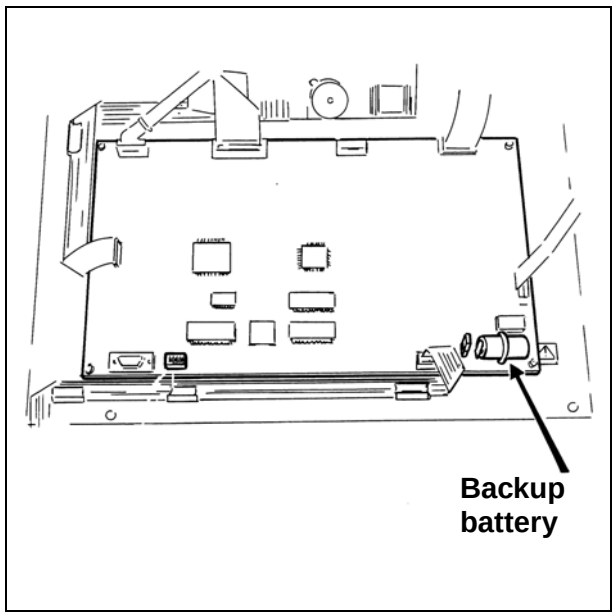



Fig. 1

## Replacing the backup battery

⚠

The backup battery can be replaced without turning off the unit. Make sure that the board does not short-circuit and that the soldering iron is not connected to main power while soldering.

- Read out the exposure counter, refer to the section "P16 - Show the exposure counter".
- Read out the mAs limit, refer to the section "P15 - upper mAs limit".
- Read out the kV step and limit, refer to the section "P14 - Number of kV steps and upper kV limit".
- Loosen the screws of the upper system cover and remove it.
- Loosen the screws and remove the protection plate.
- Locate the battery, refer to the wiring diagram, page 110.
- To avoid damage to components or assemblies, ensure compliance with ESD guidelines.
- Remove the battery jumper.
- Desolder the battery and connect the new battery using the soldering iron.
- Reattach the battery jumper.
- Reattach the aluminum plate.
- Switch off the unit for 20 s.

- Switch on the unit and check that no messages are displayed. If an Err or CAL message is displayed, proceed as follows:
- Change to service mode by switching ON S 1:1 on D1.
- Perform the adaptation according to section "P10 - Fast adaptation".
- Set the selected mAs limit, refer to the section "P15 - Upper mAs limit".
- Set the selected kV step and limit, refer to the section "P14 - Number of kV steps and upper kV limit".
- Read out the exposure counter, refer to the section "P16 - Show the exposure counter".
- Switch off S 1:1 on D1 (OFF).
- Reattach the system upper cover.

- Make an exposure at 90 kV, 10 mAs to check that everything is functioning correctly.

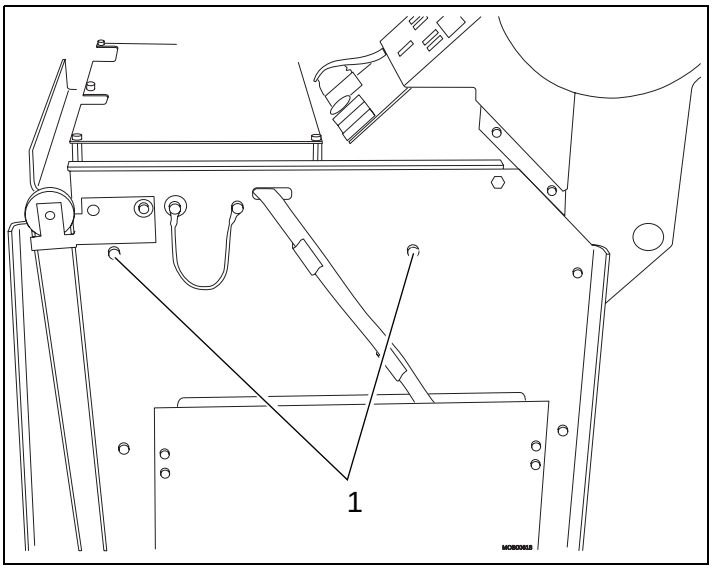



Fig. 2

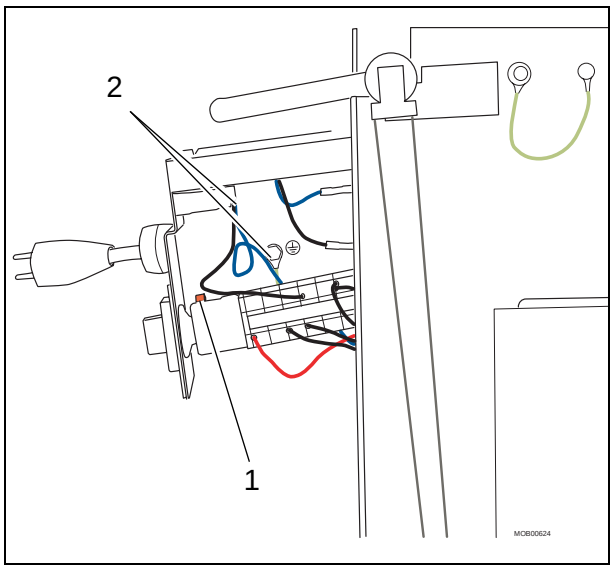



Fig. 3

## Replacement of mains cable/cable winder

- Remove the side covers and the cover with the cassette compartment.
- Remove the four (two on each side) screws that fixes the cable winder assembly (pos. 1 / Fig. 2).

**⚠CAUTION**

**Sharp edge!**

**The brake handle could be damaged.**

**Lock the brake handle, otherwise it will be damaged by the sharp upper edge of the cable winder assembly.**

- Pull out the cable winder assembly by approximately 10 cm.
- Disconnect the main switch element by turning the red lock counterclockwise (pos. 1 / Fig. 3).
- Disconnect the wires at U9/U10 and ground connection (pos. 2 / Fig. 3).

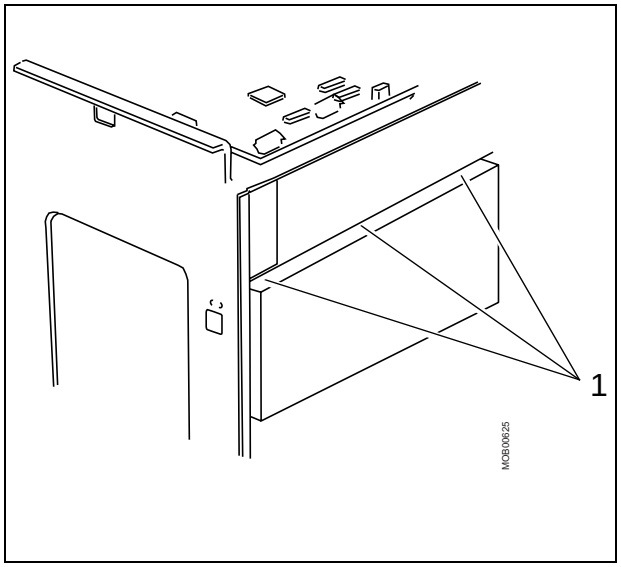



Fig. 4

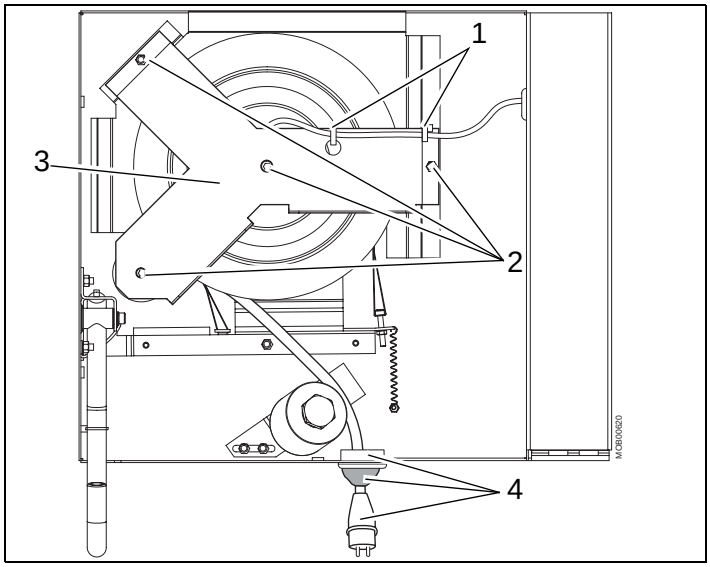



Fig. 5

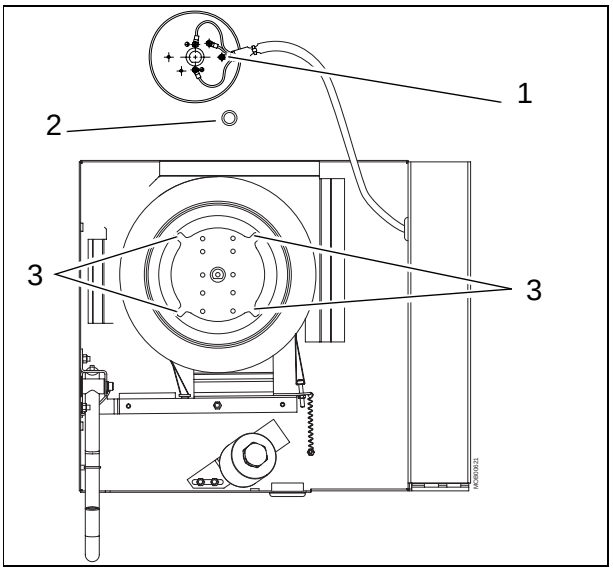



Fig. 6

- Remove the three cable ties (pos. 1 / Fig. 4).
- Remove the cable winder assembly.
- Remove the two cable ties (pos. 1 / Fig. 5).
- Remove the four screws and four nuts (pos. 2 / Fig. 5) and Y-plate (pos. 3 / Fig. 5).
- Disconnect the cable from upper plate (pos. 1 / Fig. 6).
- Remove the upper plate and distance ring (pos. 2 / Fig. 6).
- Loosen the brake carefully to loosen the tension of the cable winder spring.
- Remove the securing screw (pos. 1 / Fig. 8)
- Pull out the cable winder.

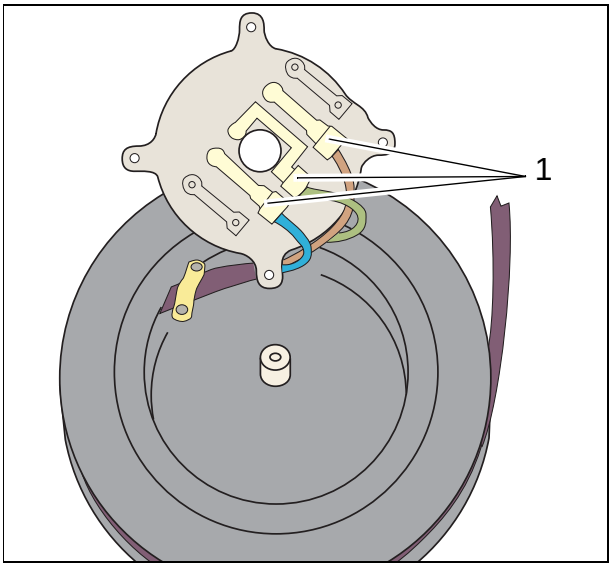



Fig. 7

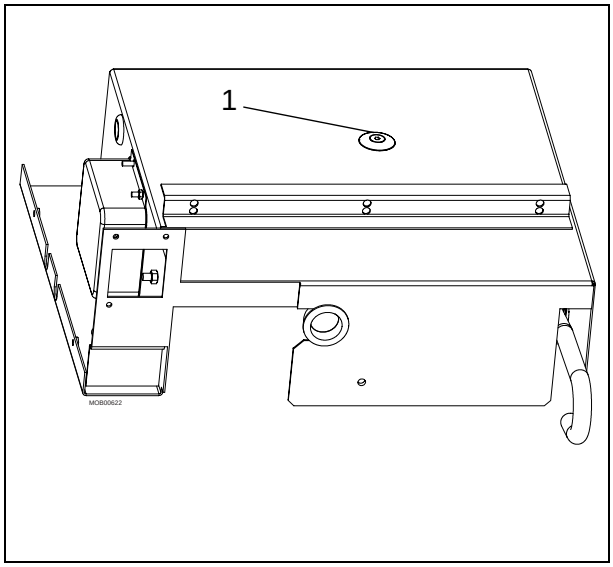



Fig. 8

- Clean cable winder box.
- Remove the plug, cable stop and ring (pos. 4 / Fig. 5).

**If the cable winder has to be replaced:**

- go to "B".

**If the mains cable has to be replaced:**

- Remove the four screws (pos. 3 / Fig. 6).
- Remove the connection plate and disconnect the mains cable (pos. 1 / Fig. 7).
- Install the new mains cable and connection plate.

| NOTE | **Wind the mains cable to the cable winder without any play.** |
|---|---|

**"B"**

- Reinstall the ring, cable stop and plug.
- Reinstall the cable winder.
- Reinstall the securing screw (pos. 1 / Fig. 8).

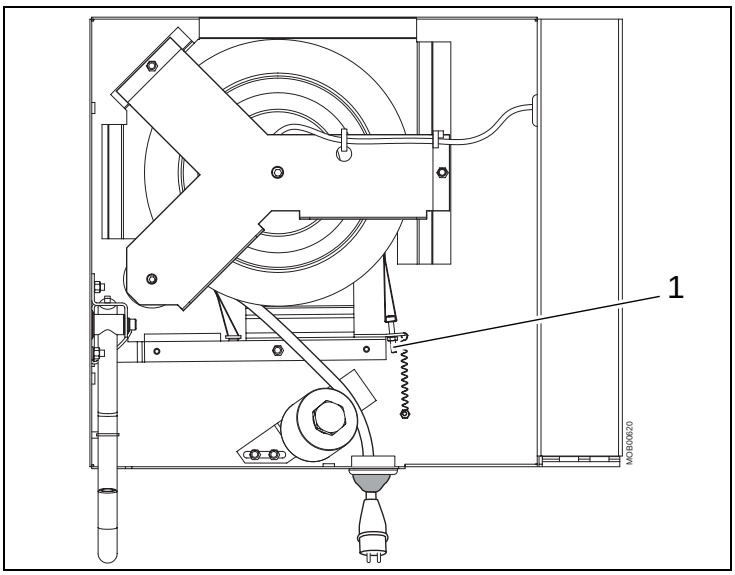



Fig. 9

- Pull out the cable and rewind it to bring the tension back to the cable winder spring. Repeat that six times.
- Reinstall the upper plate with distance ring, plastic role and Y-plate.
- Pull out the cable completely.
- Test the cable winder and brake function.

| NOTE | **The cable winder should not rewind by itself.<br>The brake force is adjusted via the right screw.<br>nut clockwise -> stronger (pos. 1 / Fig. 9).<br>nut counterclockwise -> softer.** |
|---|---|

- Reinstallation is performed in the reverse order.

| NOTICE | **During reinstallation pay special attention to the shelf of the power transmission and the rail of the cable winder assembly, which must be under the shelf!**<br><br>**We recommend that you pull out the power transmission unit to make reinstallation easier.** |
|---|---|

- Attach three new cable ties (pos. 1 / Fig. 4).

## Replacement of main switch element

- Remove the side covers and the cover with the cassette compartment.
- Remove the battery indicator (see section replacement of battery indicator).
- Remove the four screws (two on each side) that fix the cable winder assembly (pos. 1 / Fig. 2).

| ⚠CAUTION | **Sharp edge!**<br>**The brake handle could be damaged.**<br>**Lock the brake handle, otherwise it will be damaged by the sharp upper edge of the cable winder assembly.** |
|---|---|

- Pull out the cable winder assembly by approximately 10 cm.
- Disconnect the switch element by turning the red lock counter clockwise (pos. 1 / Fig. 3).

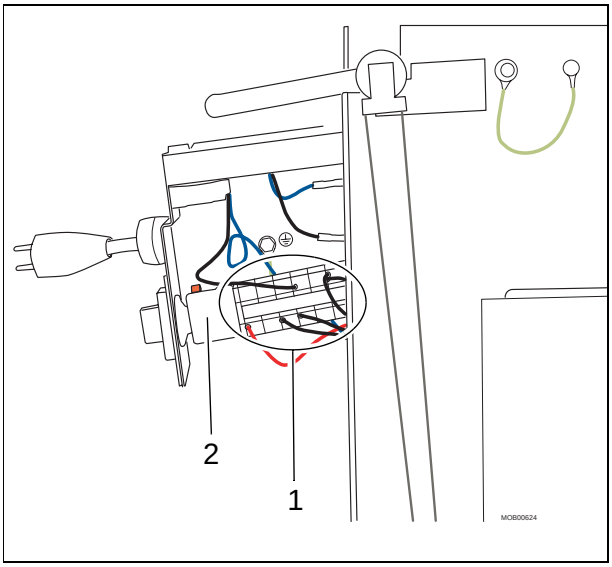



Fig. 10

- Disconnect the wires (pos. 1 / Fig. 10) and mark if necessary.

| Connection to | Connection from | Color | Connection to | Connection from | Color |
|---|---|---|---|---|---|
| S11-2 | BATT+ | RD | S11-15 | K201:3 | BU |
| S11-3 | K202:3 | BU | S11-16 | Fuse U9 | BU |
| S11-10 | K52:3 | BK | S11-19 | K52:1 | BU |
| S11-12 | K104:1 | RO | S11-21 | K104:4 | BK |
| S11-12 | K202:2 | YE | S11-21 | BATT- | BK |
| S11-13 | Fuse U10 | BK | S11-23 | K301-2 | BU |
| S11-14 | K201:1 | BK | S11-24 | K301:1 | RO |

- Replace switch element (pos. 2 / Fig. 10).

Reinstallation is performed in the reverse order.

**NOTICE**

**During reinstallation pay special attention to the shelf of the power transmission and the rail of the cable winder assembly, which must be under the shelf!**

**We recommend that you pull out the power transmission unit to make the reinstallation easier.**

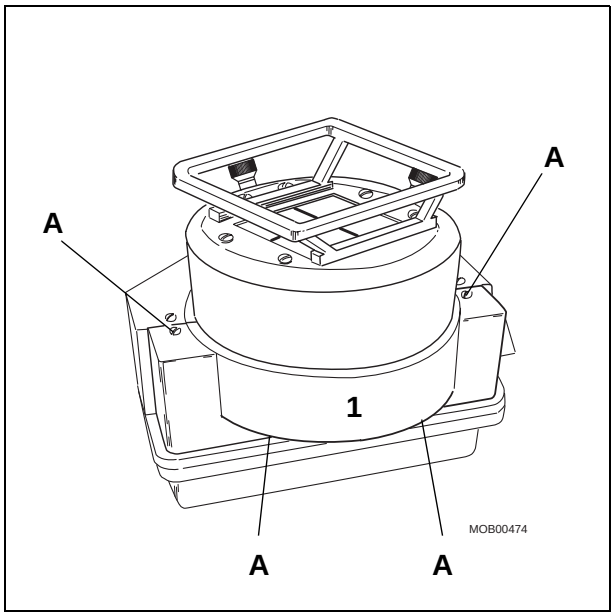



Fig. 1

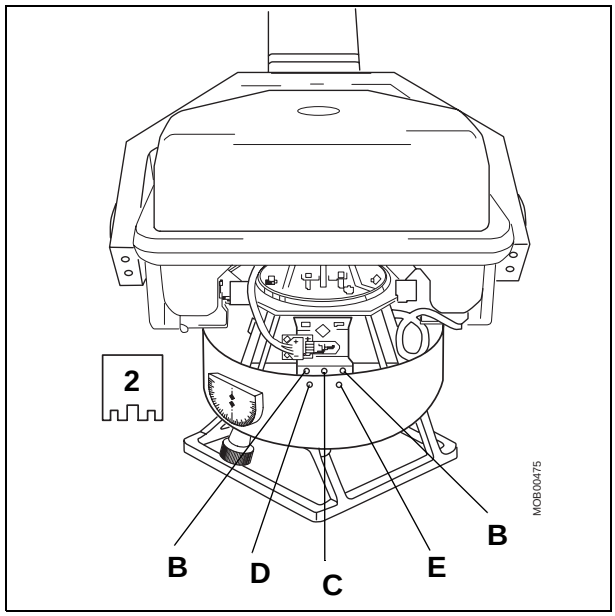



Fig. 2

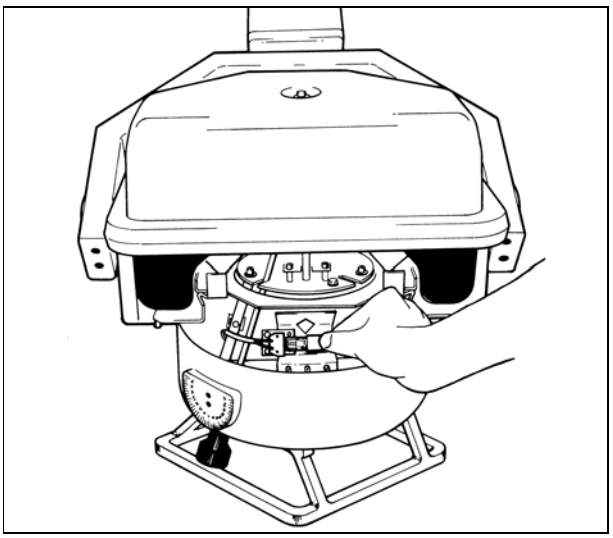
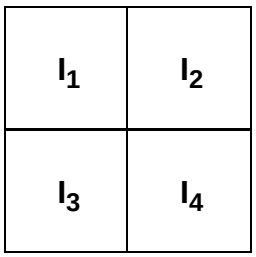


Fig. 3

## Replacing the collimator lamp

**Equipment required:** Lux meter

- Remove the cover (1) by removing the screws (4) marked "A" (Fig. 1). Turn the collimator around so that the lamp housing is in front of the cover opening.
- Remove the protective plate (2) covering the collimator lamp by loosening, not removing, the screws marked "B" by one turn. Do not adjust screws "C", "D", or "E" (Fig. 2).
- Remove the defective lamp and replace it with a new lamp (Fig. 3). **Do not touch the bulb with bare fingers**. (See "list of spare parts".)
- Reinstall the protective plate. Tighten the screws marked "B".




$I_{Light\ field} = 1/4\ [I_1 + I_2 + I_3 + I_4) - 4I_{Room\ light}]$

Fig. 4

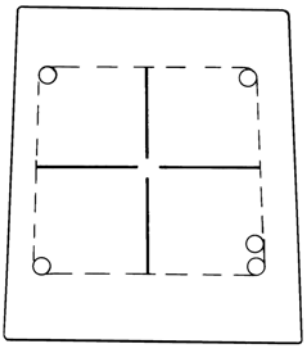


Fig. 5

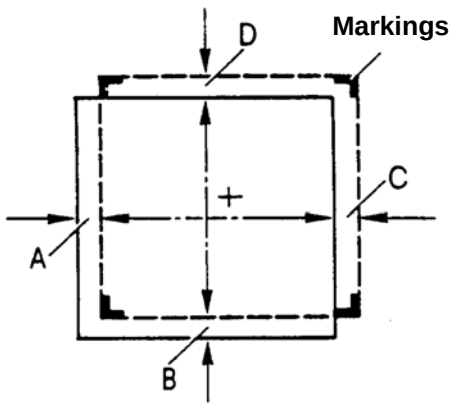



Fig. 6

**A + C** ≤ **1.7 %**
**SID**

**B + D** ≤ **1.7 %**
**SID**

**SID = Source-Image Distance**

**---------- Light field**

**_____ X-ray field**

## Checking the light intensity

**Equipment required:** Lux meter

| NOTE | **If the MOBILETT is equipped with a DAP measuring system, remove the DAP ionization chamber first.** |
|---|---|

When a collimator lamp is used to define the X-ray field, it shall provide an average illumination of no less than 180 lux at 100 centimeters. The average illumination shall be based upon measurements made in the approximate center of each quadrant of the light field (Fig. 4).

If the illumination is less than 180 lux, check the lamp supply. Refer to wiring diagram X037E, page 180.

### Light field relative to the X-ray field

**Equipment required:** Cassette, X-ray film and coins

| NOTE | **If the MOBILETT is equipped with a DAP measuring system, remove the DAP ionization chamber first.** |
|---|---|

- Load a 35 x 35 cm (14" x 14") cassette with film.
- Place the cassette on a table or a similar surface.
- Set a SID of 100 cm (39"). Use a measuring tape.
- Switch on the collimator lamp and align the cassette. Collimate the light field to 25 x 25 cm (10" x 10").
- Mark the four corners with coins and mark one of the corners with two coins (Fig. 5).
- Set 52 kV, 2.0 mAs on the control panel.

| ⚠CAUTION | **X-ray radiation!**<br>**If not observed, risk of radiation exposure.**<br>**Use radiation protection!** |
|---|---|

- Release an exposure.
- Develop the film and measure the deviation between the light and the radiation field. Acceptable deviation ± 1.7% of SID, (Fig. 6).
- If the deviation is more than 1.7%, adjust with the screws marked C and D (Fig. 2) to move the light field closer to the radiation field.
- Repeat the test with a new exposure.
- If necessary, adjust again until the deviation between the light field and the radiation field is within the tolerance specified.
- Reattach cover 1 (Fig. 1).

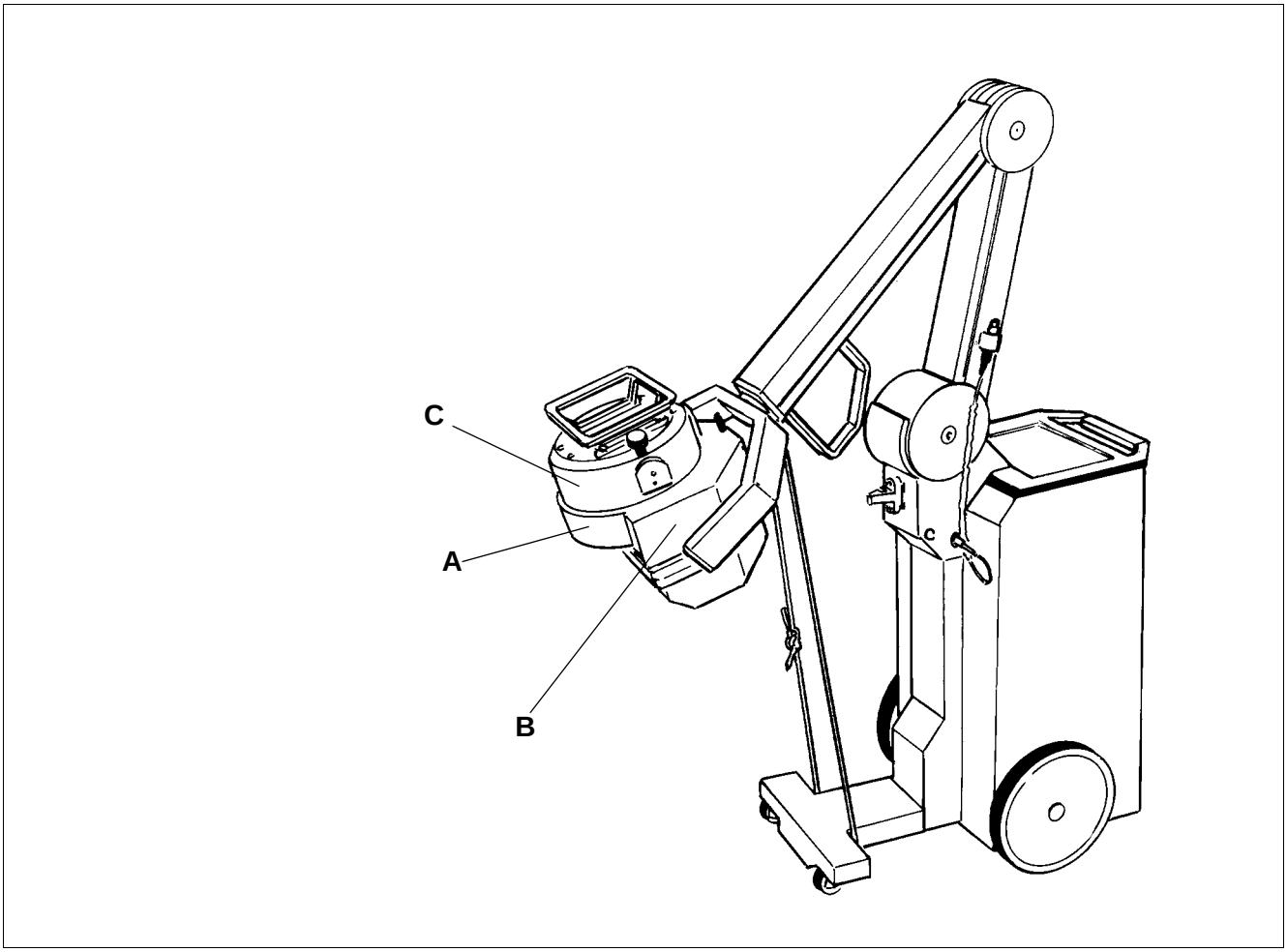



Fig. 7

## Replacing the collimator

**Equipment required:** rope

- Switch off the unit and disconnect the power plug.
- Turn the single tank so that the collimator is facing upwards (Fig. 7).
- Secure the arm and the single tank with a rope (Fig. 7).
- Remove covers "A" and "B".
- Remove collimator cover "C".

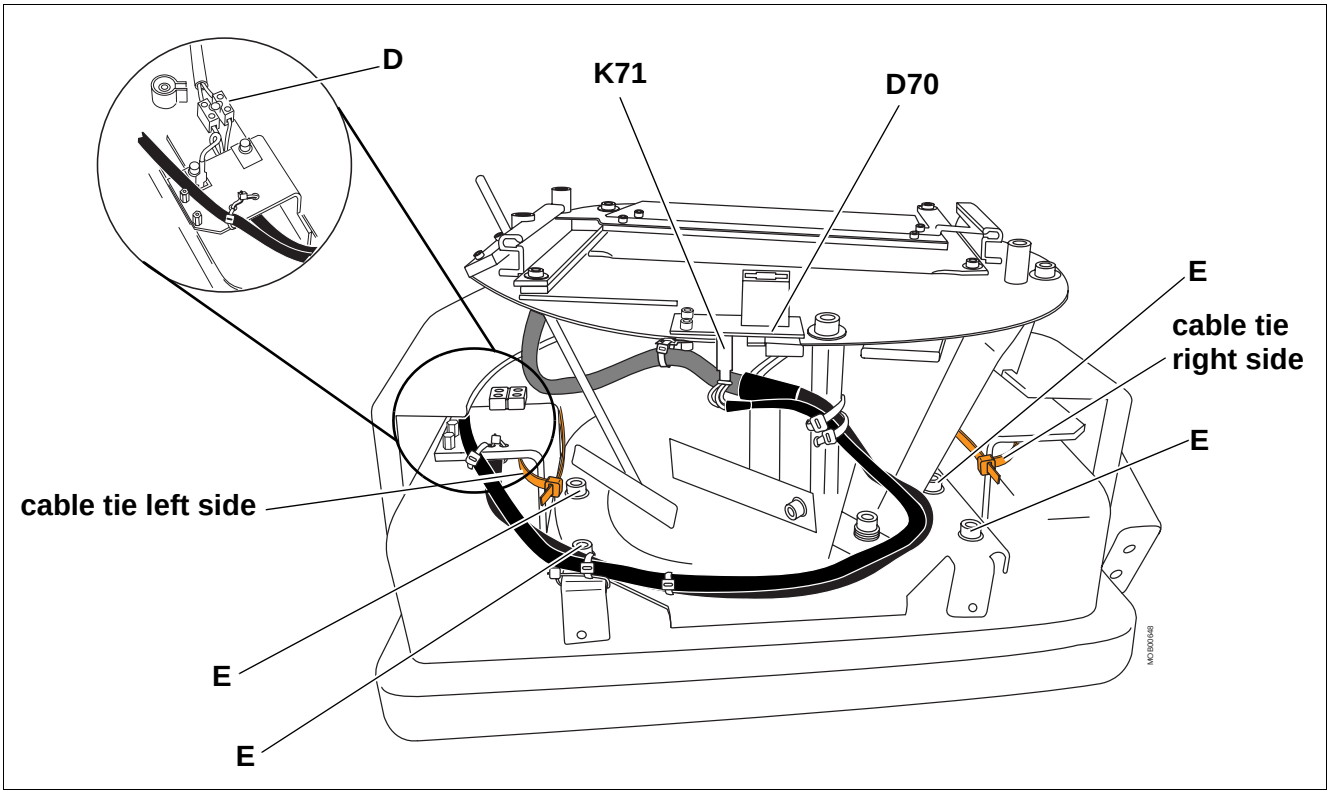



Fig. 8

- Disconnect the cable to the connection terminal board "D" (Fig. 8).
- Disconnect K71 from board D70 (Fig. 8).
- Remove the cable ties on the left and the right side (Fig. 8).
- Remove the five cable ties according to "F" (Fig. 9).

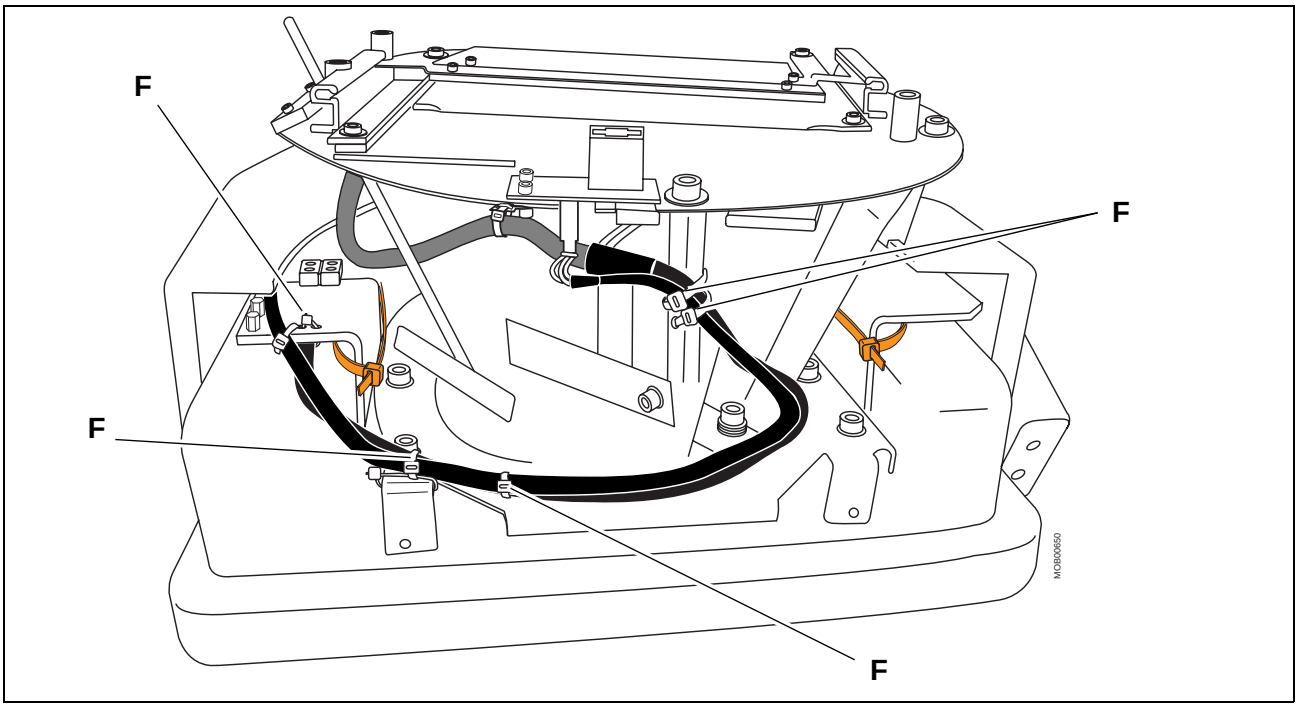



Fig. 9

- Remove the collimator by loosening the four screws "E" (Fig. 8). Reserve the hardware.
- Install the new collimator. Center the rotary-flange so that the screws marked "E" are centered in the grooves before tightening.
- Connect the wires to connection terminal board "D".
- Replace the cable ties (Fig. 8). The cable ties have to be mounted exactly as shown in Fig. 8, Fig. 10 and Fig. 11. The cable ties should not be tightened hard. Fig. 10 and Fig. 11 show how the cable tie on the right side is mounted. Repeat for the left side, but with the cable tie mirror-inverted.

| NOTE | **Do not to forget to attach the cable ties!** |
|---|---|

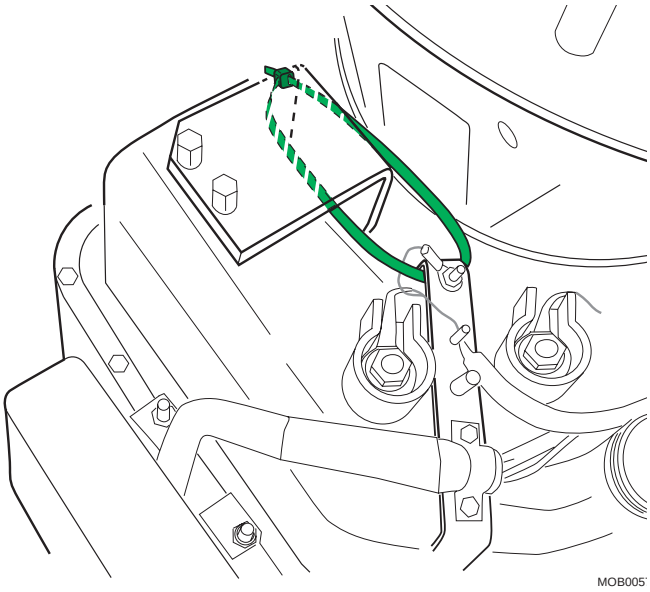



Fig. 10

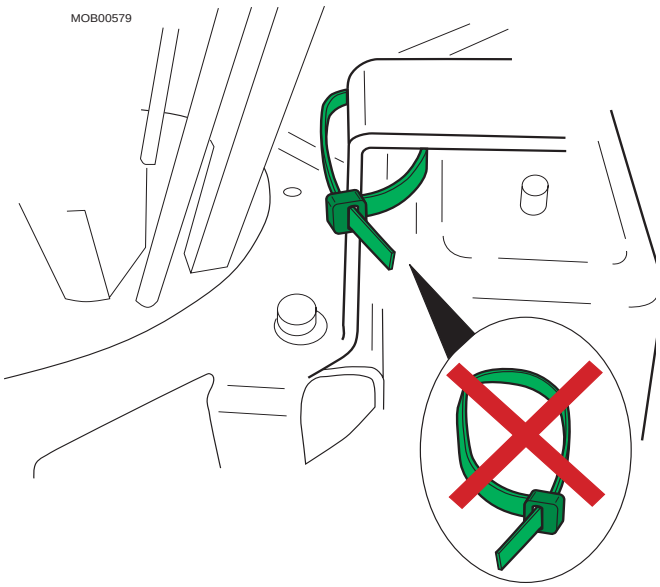



Fig. 11

- Reconnect K71 to board D70 (Fig. 8).
- Replace the five cable ties shown in Fig. 9. Make sure they are fastened exactly as shown in the figure.
- Rotate the collimator through the whole interval and make sure the cable ties do not come in contact with the collimator / moving parts.
- Reattach collimator cover "C".

| NOTICE | **When replacing the collimator, the new collimator should be positioned and adjusted so that the light and radiation fields correspond.**<br><br>**The adjustment should be performed by moving the whole collimator, not just by changing the position of the collimator bulb.** |
|---|---|

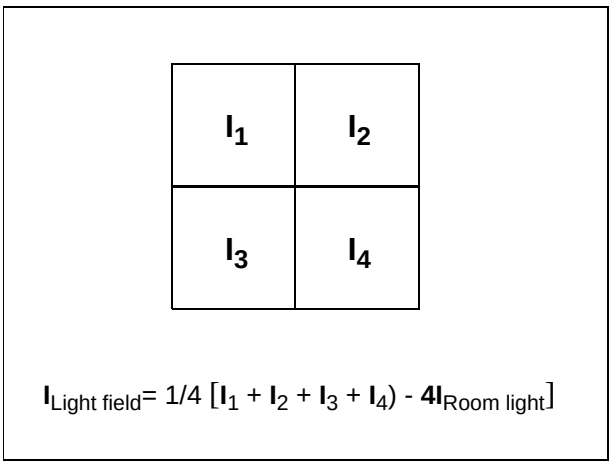



Fig. 12

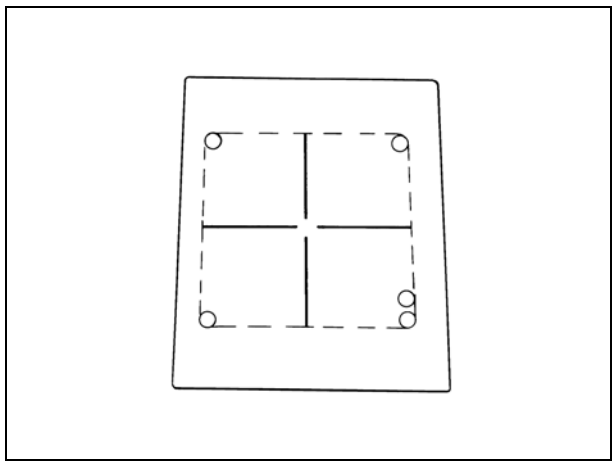
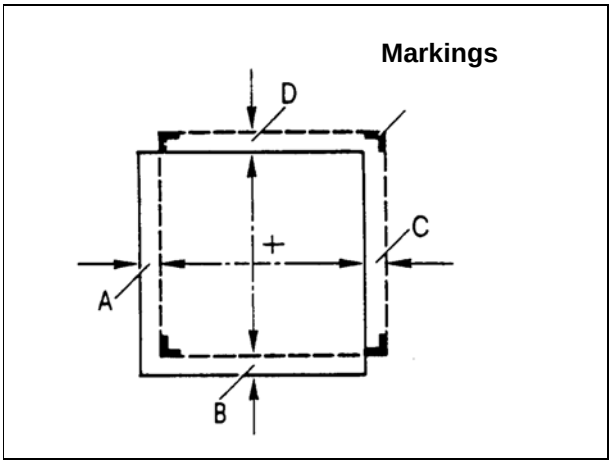


Fig. 13




**A + C** ≤ **1.7 %**
**SID**

**B + D** ≤ **1.7 %**
**SID**

**SID = Source-Image Distance**

**---------- Light field**

**_____ X-ray field**

Fig. 14

### Checking the light intensity

**Equipment required:** Lux meter

| NOTE | **If the MOBILETT is equipped with a DAP measuring system, remove the DAP ionization chamber first.** |
|---|---|

When a collimator lamp is used to define the X-ray field, it shall provide an average illumination of no less than 180 lux at 100 centimeters. The average illumination shall be based upon measurements made in the approximate center of each quadrant of the light field (Fig. 12).

If the illumination is less than 180 lux, check the lamp supply. Refer to wiring diagram X037E, page 180.

### Light field relative to the X-ray field

**Equipment required:** Cassette, X-ray film and coins

**NOTE** **If the MOBILETT is equipped with a DAP measuring system, remove the DAP ionization chamber first.**

- Load a 35 x 35 cm (14" x 14") cassette with film.
- Place the cassette on a table or a similar surface.
- Set a SID of 100 cm (39"). Use a measuring tape.
- Switch the main switch to position "B".
- Switch on the collimator lamp and align the cassette. Collimate the light field to 25 x 25 cm (10" x 10").
- Mark the four corners with coins and mark one of the corners with two coins (Fig. 13).
- Set 52 kV, 2.0 mAs on the control panel.

**⚠CAUTION**

**X-ray radiation!**

**If not observed, risk of radiation exposure.**

**Use radiation protection!**

- Release an exposure.
- Develop the film and measure the deviation between the light and the radiation field. Acceptable deviation ± 1.7% of SID (Fig. 14).

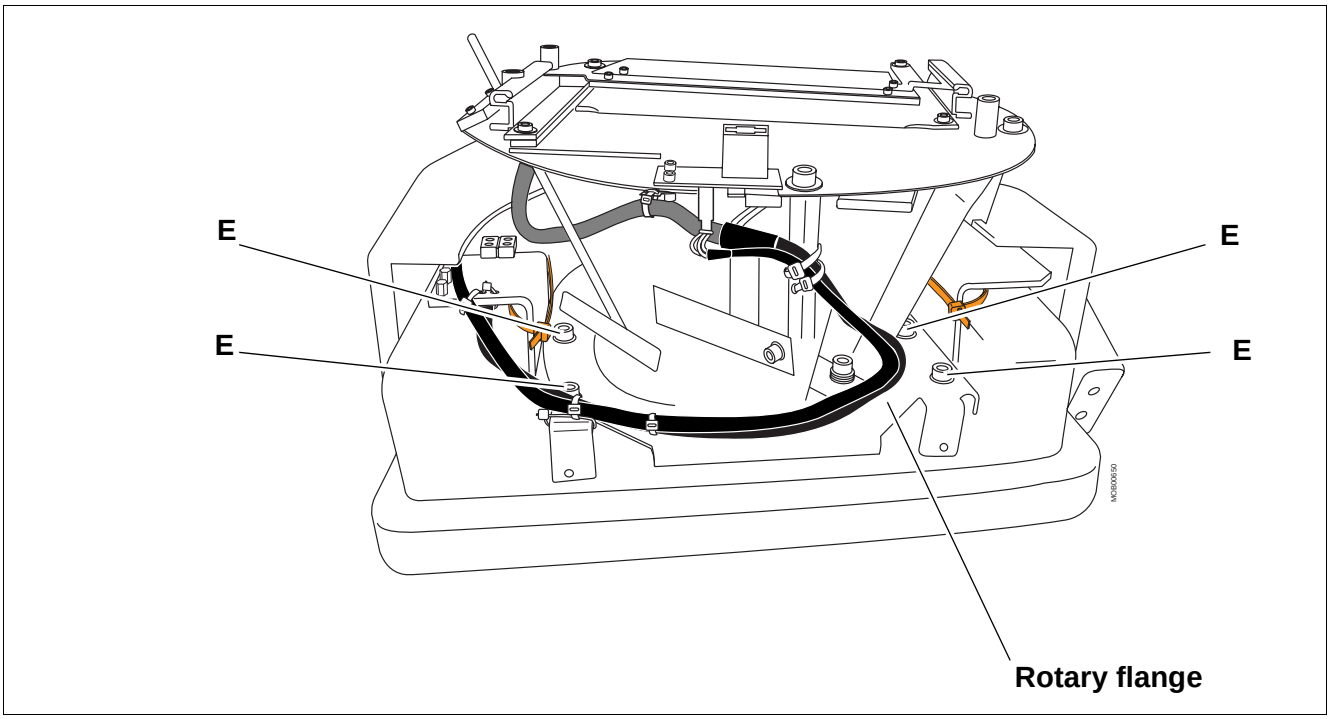



Fig. 15

- If the deviation is more than 1.7%, loosen the Allen screws marked "E" slightly and move the rotary-flange to the desired position.
- Tighten the screws marked "E" (Fig. 15).
- Repeat the test and adjustment of the rotary flange position until the deviation between the light and radiation fields is within the tolerance specified.
- Reinstall covers "A" and "B".

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## Adjusting the arm system

⚠DANGER

**High Voltage!**

**Life-threatening hazard of electric shock. Never work with the system open if the batteries are still connected and the capacitor is charged. If the batteries are connected, the complete system is powered on!**

**The capacitors in M10 and M11 may still be charged even if the system is switched OFF and the mains cable is disconnected. The capacitors in M10 and M11 must be considered charged until the protective measures listed in this section have been performed.**

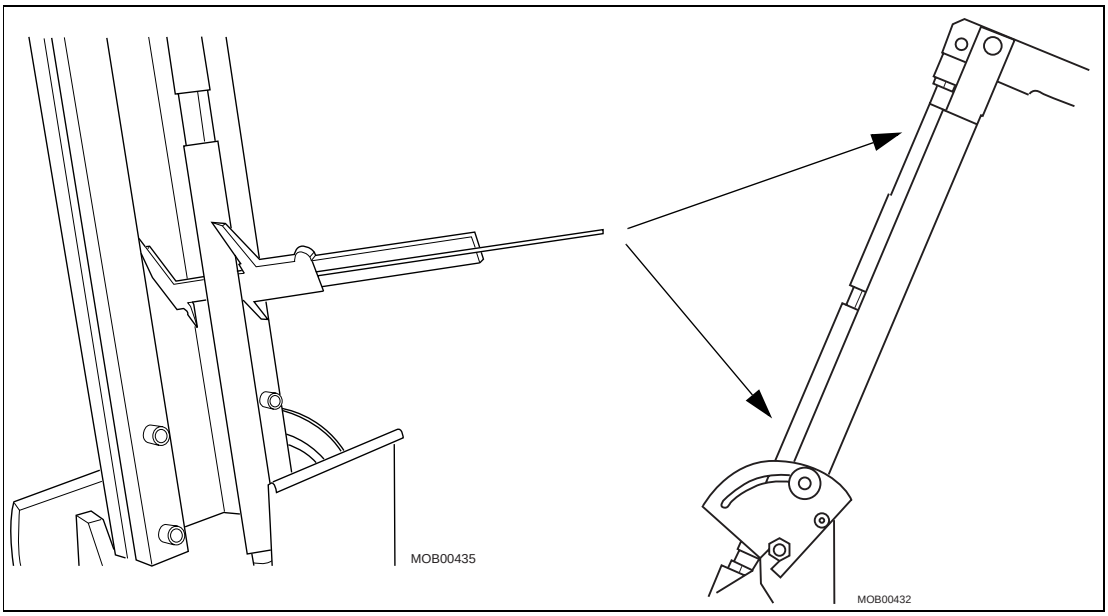



Fig. 1

### Parallelism

**Equipment required:** Slide caliper and a rope. If the parallelism must be adjusted, a ceiling support is required.

The parallelism adjustment affects the maximum height and the counterbalance and must be performed prior to performing any other adjustments of the arm system.

- Remove all arm and joint covers so that the adjustment rod is visible (Fig. 1).
- The adjustment rod must always be parallel with the arm. This can be checked by measuring at two points as far away from each other as possible but with the same diameter of the pull rod (Fig. 1). The parallelism must not deviate by more than 0.6 mm. The measurements must be performed with the arm in the uppermost and lowermost positions. If not parallel, loosen the locking nuts and adjust by turning the pull rod.

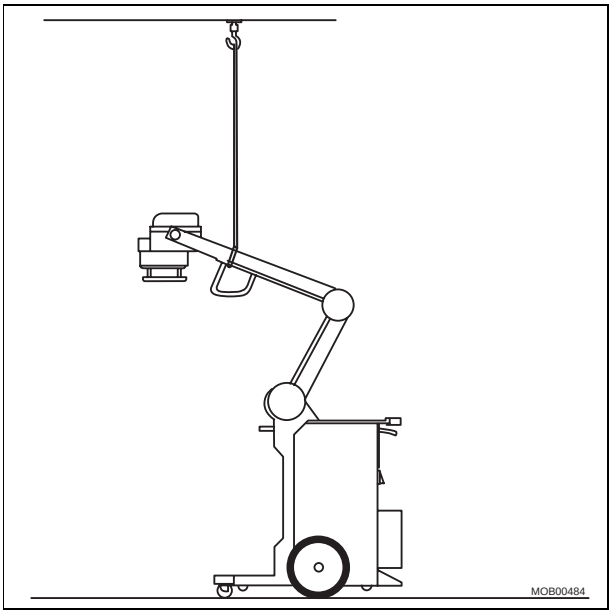



Fig. 2

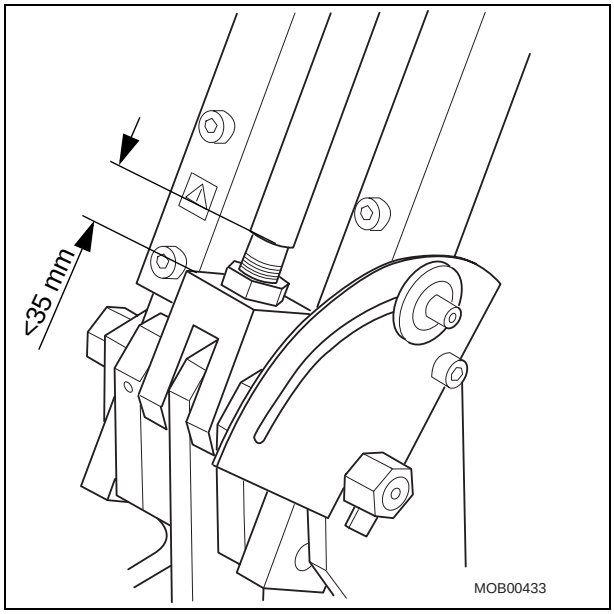



Fig. 3

**⚠WARNING**

**Danger of personal injury !**

- **Make sure the visible part of the thread between the link and the key grip at the adjustment rod is always less than 35 mm (Fig. 3). If the visible part of the adjustment rod is longer than specified, the single tank and the arm might fall**.

**If any adjustment is needed, the single tank should be secured in its uppermost position with a ceiling support (Fig. 2). After the single tank has been secured, the two nuts can be loosened and the adjustment rod can be turned.**

- **Lock the rod with the nuts and repeat the parallelism check until it is within the specified limit.**

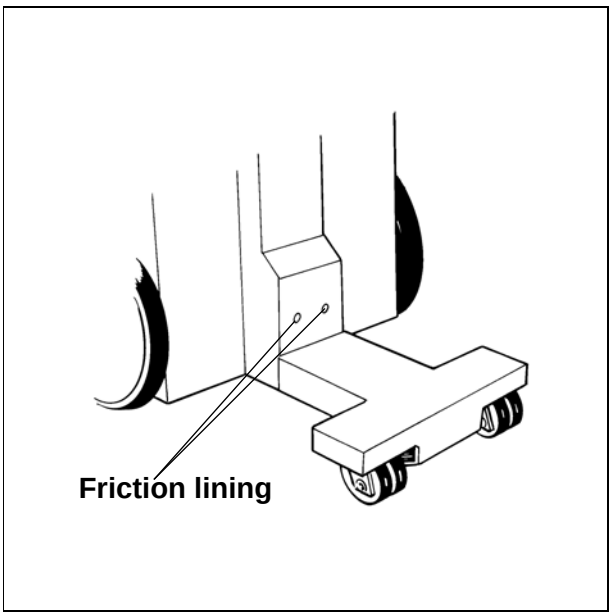



Fig. 4 For upper arm stability

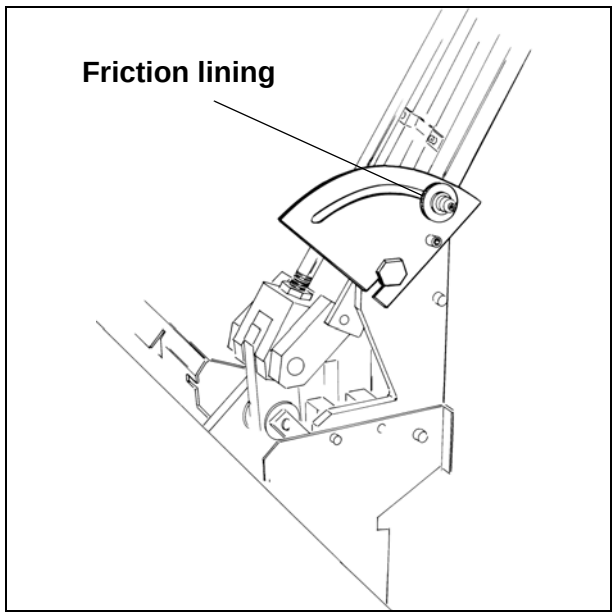



Fig. 5 For lower arm stability

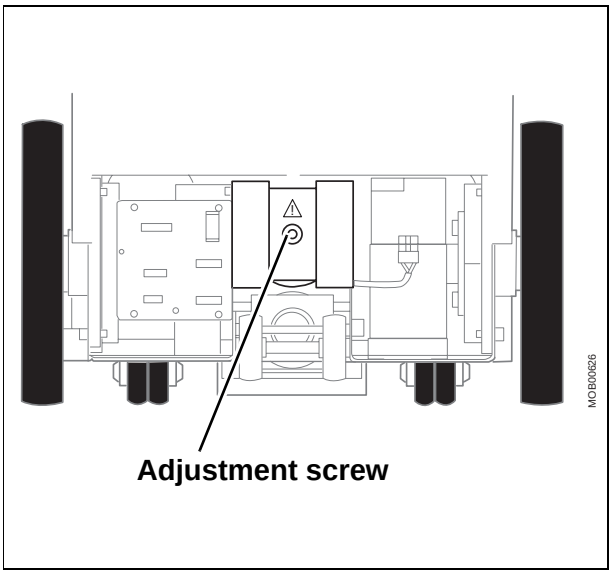



Fig. 6

## Counterbalance

- Remove the plastic plugs covering the friction linings in the column.
- Loosen the friction linings through the holes in the column (Fig. 4) and the lining in the lower joint (Fig. 5).
- Check that the arm system stops in any position.
  If does not stop, but moves lower or higher:
- Adjust the arm system with the adjustment screw (Fig. 6) until it balances in all positions.
  If the arm moves lower, the screw must be tightened; if it moves up, the screw must be loosened.

## Adjusting the friction linings

### Upper arm

If the upper arm does not hold the position set, the friction lining can be adjusted through the holes in the cover (Fig. 4).

- Loosen the screws completely with a 4 mm Allen wrench.
- Retighten the screws until there is no play.
- Tighten the screws evenly until the upper arm holds its position but is still easy to move.

### Lower arm

If the lower arm does not hold its position, it must be adjusted (Fig. 5).

- Loosen the screw completely.
- Retighten the screw until there is no play.
- Tighten the screw until the lower arm holds its position but is still easy to move.
- Reattach the cover.

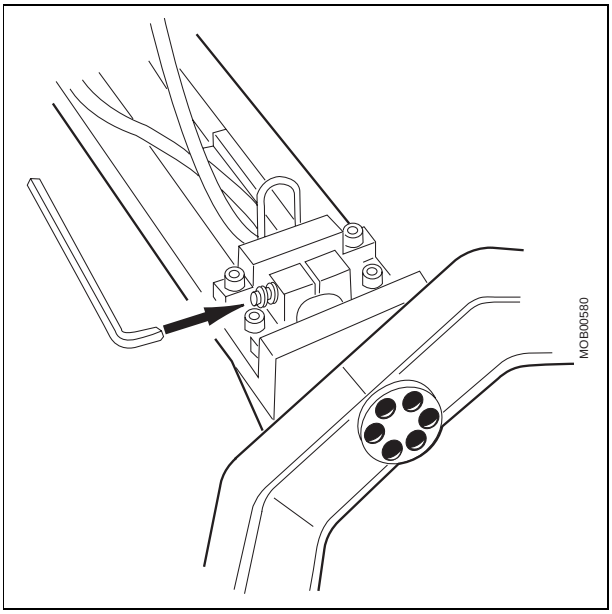



Fig. 7

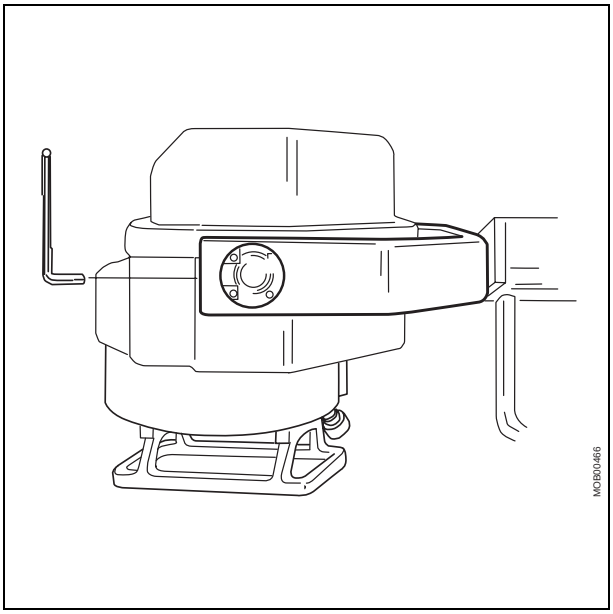



Fig. 8

**Movement of the fork**

If the fork does not hold its position, it must be adjusted (Fig. 7).

- Loosen the screw completely.
- Retighten the screw until there is no play.
- Tighten the screw until the fork holds its position.

**Movement of the single tank**

If the single tank rotates too easily or does not hold its position in the fork:

- Remove the caps on the fork.
- Tighten or loosen the friction adjustment (one on each side of the fork) (Fig. 8).

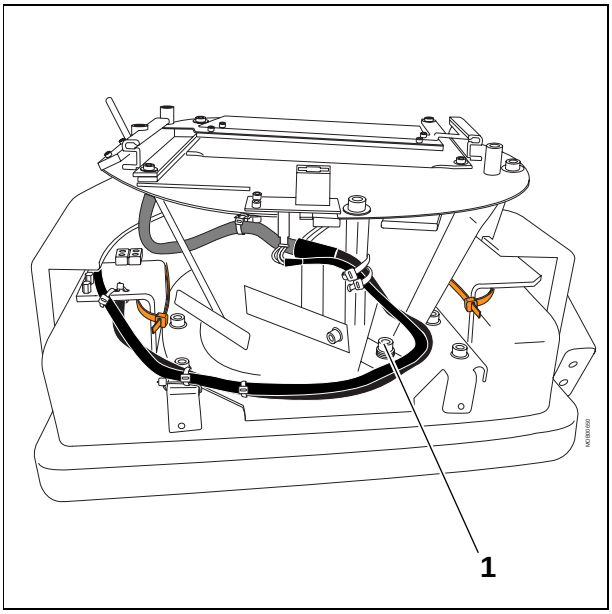



Fig. 9

**Movement of the collimator**

- Remove the collimator cover.
- Adjust the collimator movement resistance with the screw (1) (Fig. 9).
- Reattach all covers.

## Replacing the spring pack

⚠DANGER

**High Voltage!**

**Life-threatening hazard of electric shock. Never work with the system open if the batteries are still connected and the capacitor is charged. If the batteries are connected, the complete system is powered on!**

**The capacitors in M10 and M11 may still be charged even if the system is switched OFF and the mains cable is disconnected. The capacitors in M10 and M11 must be considered charged until the protective measures listed in this section have been performed.**

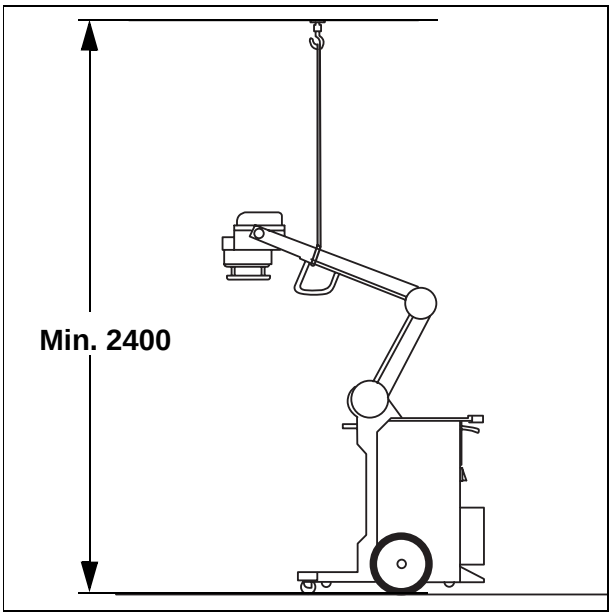



Fig. 10

**Equipment required:** 2 pieces of wood (50 x 70 x 500 mm), rope, ceiling support and a protective mat.

NOTICE

**Difficult operations.**

**We recommend that two service engineers perform this replacement.**

- Ensure compliance with the safety information in the section: "Safety information and protective measures".
- Block the rear wheels and apply the parking brake.
- Jack up and block the unit securely 5 cm above the floor. This must be done properly so that the unit does not tip over.

- Remove the upper column cover by removing the transport handle and the lower column cover by lifting it upwards.
- Raise the single tank to maximum height and secure it with a ceiling support (Fig. 10).

| ⚠CAUTION | **The ceiling suspension must be able to hold a weight of 100 kg since the entire weight of the arm will be on the ceiling support once the spring is removed.**<br>**If not, the arm and single tank will fall.**<br>**Make sure the ceiling support is sufficient.** |
|---|---|

| NOTE | **Do not stand under the single tank or the arm system during the work that follows.** |
|---|---|

- Remove the supporting wheels.
- Put the protective mat under the unit to protect the floor from damage.

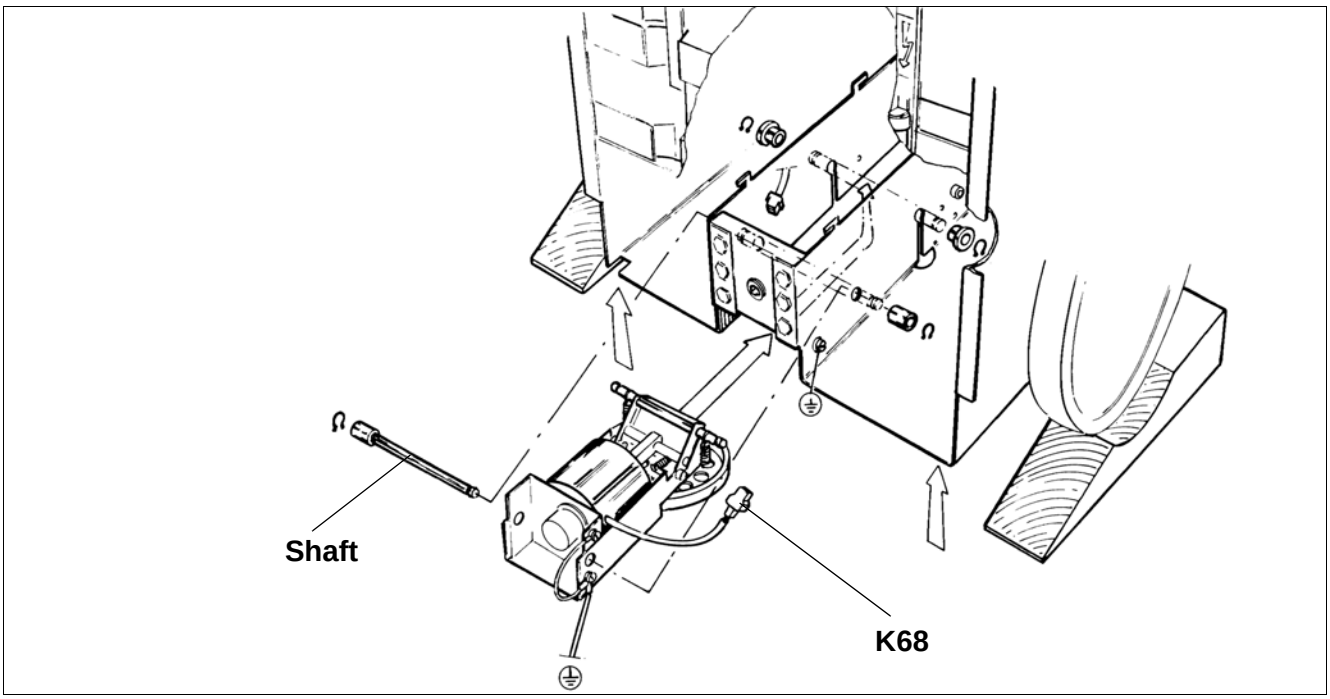



Fig. 11

- Remove battery charger D201 and motor power unit D102 (see section 7 and 11).
- Disconnect all cables, ground connections and K68 according to (Fig. 11).
- Remove the locking rings.
- Remove the bearing rings.
- Remove the shaft.
- Let the turn plate down and remove it.

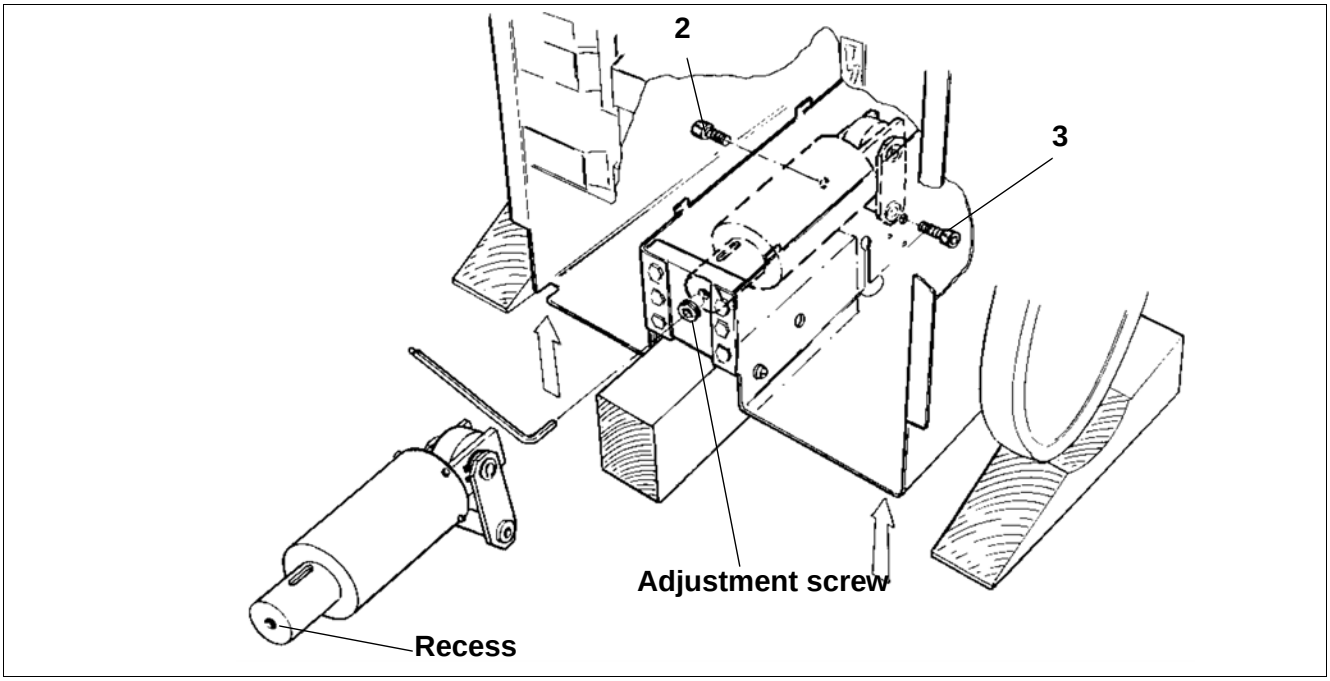



Fig. 12

**⚠WARNING**

**Risk of injury to the hands!**

**The strong tension in the spring pack could cause undesirable actions.**

**Be careful during the following procedures.**

- Loosen the adjustment screw so that the spring pack is loosened and the nearest part of the pack is lowered (Fig. 12).

**⚠WARNING**

**If the spring pack does not lower, there is still spring tension.**

**The strong tension in the spring pack could cause undesirable actions.**

**Check whether the single tank is in its uppermost position; if not, raise the single tank to this position. Check whether the adjustment screw is loose enough. Do not use any force to remove the spring pack.**

- Loosen the two large Allen screws (2) and (3) on the end of the spring pack. The whole spring pack will then fall down on the floor.
- Remove the spring pack.
- Install the new spring pack with the two Allen screws (2) and (3) on the end of the spring pack.
- Lift up the spring pack in the front end and check through the hole for the adjustment screw that the front of the spring pack with recess is visible.
- Mount the adjustment screw and tighten until the spring pack is held in position.

- Tighten screws (2) and (3).
- Tighten the adjustment screw until the arm and single tank are held in the uppermost position by the spring force alone.

The installation of the turn plate is performed in the reverse order.

- Install the turn plate.
- Reattach the shafts.
- Reattach the bearing rings.
- Reattach the locking rings.
- Connect the ground cable and K68.
- Reinstall the supporting wheels.
- Remove the ceiling support carefully and check that the single tank remains in the uppermost position by itself. If not, tighten the adjustment screw.
- Move the arm into the park position.
- Lower the unit to the floor and block the rear wheels.
- Check the arm and single tank movement. If necessary, adjust according to section "Adjustment of the arm system".
- Reattach all covers.
- Check the function of the turn plate by pressing one of the turn plate buttons and turning the unit. Check also that the turn plate returns to the park position when the button is pressed a second time.

- Check the unit by releasing an exposure.

## Adjustment and replacement of the turn plate

⚠DANGER

**High Voltage!**

**Life-threatening hazard of electric shock. Never work with the system open if the batteries are still connected and the capacitor is charged. If the batteries are connected, the complete system is powered on!**

**The capacitors in M10 and M11 may still be charged even if the system is switched OFF and the mains cable is disconnected. The capacitors in M10 and M11 must be considered charged until the protective measures listed in this section have been performed.**

**Equipment required:** 2 pieces of wood (50 x 70 x 500 mm)

- The turn plate mechanism must be removed for adjustment or replacement.
- Ensure compliance with the safety information in the section: "Safety information and protective measures".

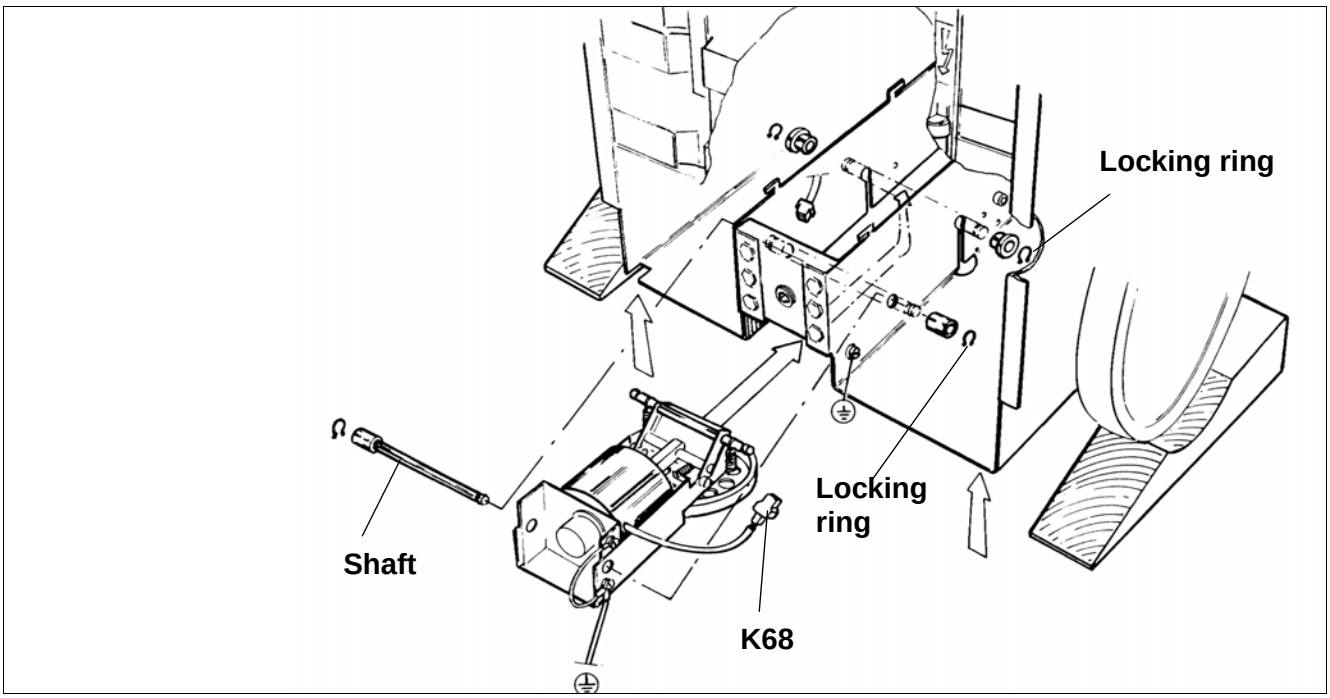



Fig. 13

- Remove the supporting wheels.
- Jack up and block the unit securely 5 cm above the floor. This must be done properly so that the unit does not tip over.
- Remove battery charger D201 and motor power unit D102 (see section "7" and "11").
- Disconnect all cables, ground connection and K68 according to (Fig. 13).

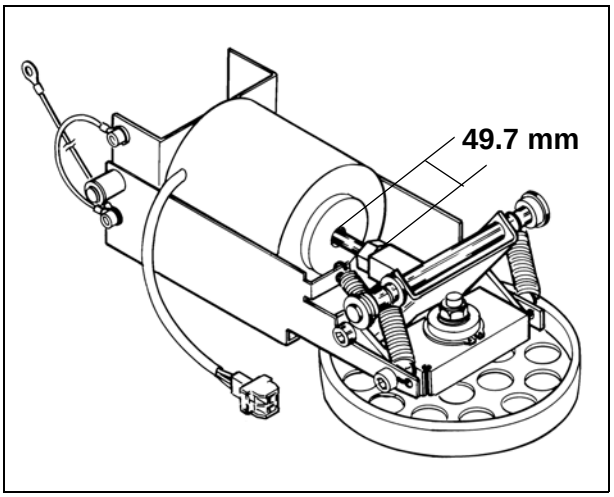



Fig. 14

- Remove the locking rings.
- Remove the bearing rings.
- Remove the shaft.
- Lower the turn plate and remove it.
- Check all springs for correct mounting and damage (Fig. 14).
- Check that the dimension between the screw connection and the magnet housing is 49.7 mm. Adjust if necessary.

A new or inspected turn plate should be installed in the reverse order:

- Reinstall the turn plate.
- Reinstall the shafts.
- Reinstall the bearing rings.
- Reinstall the locking rings.
- Connect the ground cable and K68.
- Reinstall the supporting wheels.
- Reconnect the KBATT plugs.
- Reattach the side covers and the cover with the cassette compartment.
- Set switch S10 in OFF position to charge the capacitor bank.
- Reattach the system upper cover.
- Connect the unit to mains power supply outlet and switch it on.
- Reattach all covers.
- Check the function of the turn plate by pressing one of the turn plate buttons and turning the unit. Check also that the turn plate returns to the park position when the button is pressed a second time.

- Check the unit by releasing an exposure.

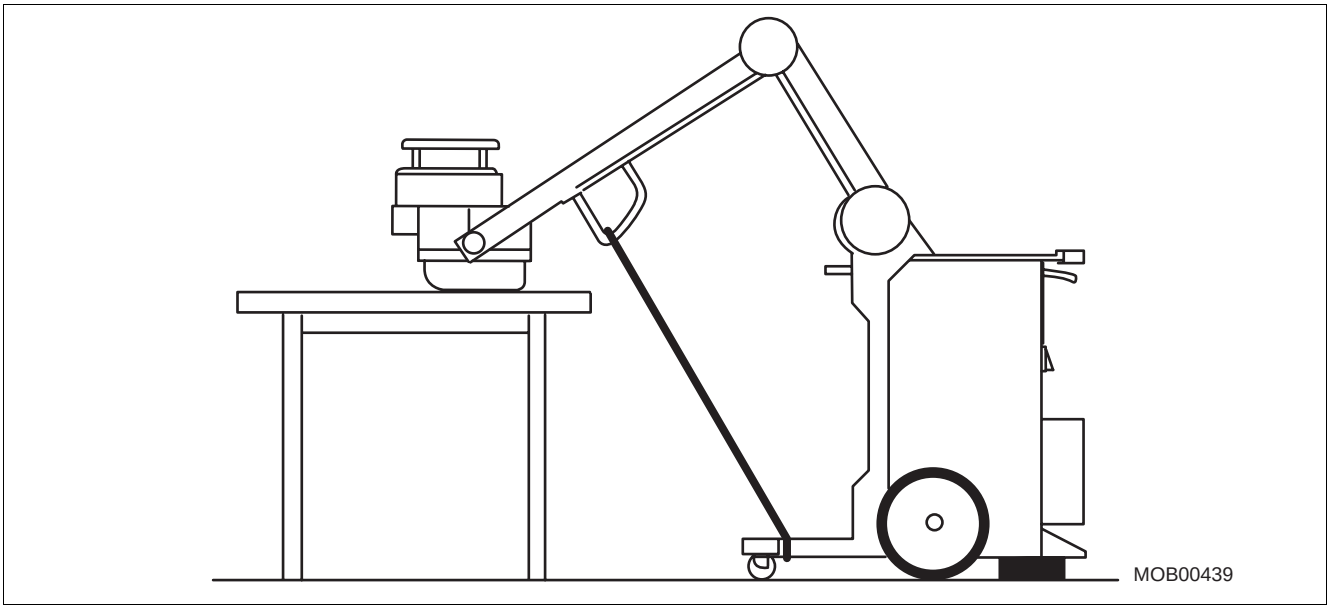



Fig. 15

## Replacement of the single tank

**⚠DANGER**

**High Voltage!**

**Life-threatening hazard of electric shock. Never work with the system open if the batteries are still connected and the capacitor is charged. If the batteries are connected, the complete system is powered on!**

**The capacitors in M10 and M11 may still be charged even if the system is switched OFF and the mains cable is disconnected. The capacitors in M10 and M11 must be considered charged until the protective measures listed in this section have been performed.**

**Equipment required:** Rope

- Position the unit with the single tank resting on a table (Fig. 15).
- Secure the arm with a rope.
- Block the rear wheels and apply the parking brake.

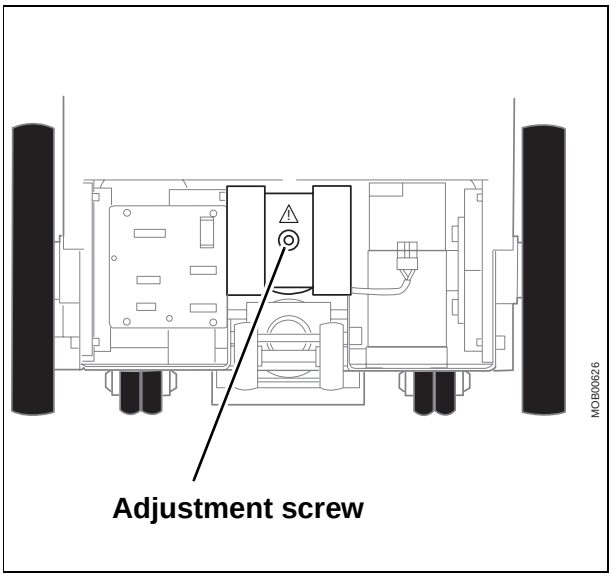



Fig. 16

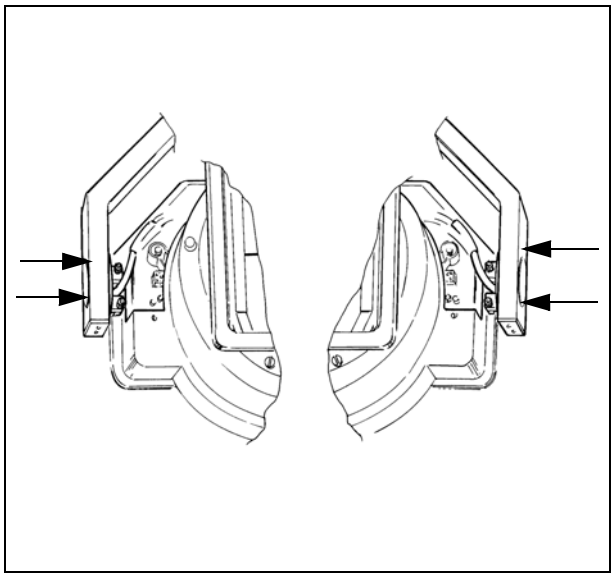


Fig. 17

- Relieve the spring tension by loosening the adjustment screw (Fig. 16).
- Remove all collimator covers and grounding cables.
- Disconnect all cables to the collimator.
- Remove the collimator according to the information in chapter 9.
- Disconnect all electrical connections to the single tank.
- Remove the screws and nuts (Fig. 17) bolts placed in the ends of the axis of rotation.
- Lift up the fork and remove the single tank. **Do not turn the fork around**.
  The new single tank has to be installed in the same position as the old one.
- Replace the locking nuts with new nuts enclosed with the new single tank.
- Install the four screws according to Fig. 17.

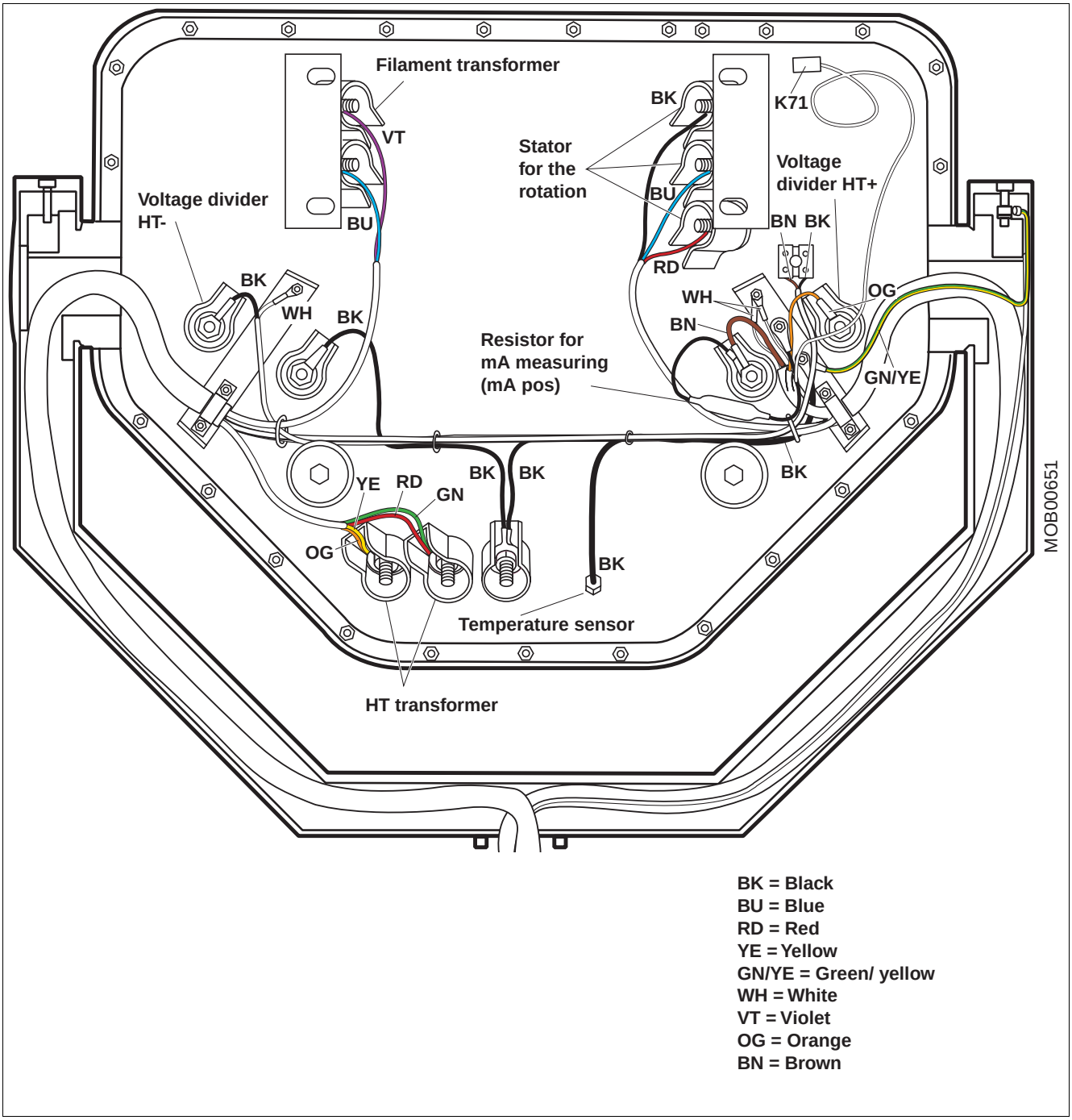



Fig. 18

- Reconnect all electrical connections according to Fig. 18.
- Install the collimator and replace the cable ties according to the information in chapter 9.
- Tighten the adjustment screw (Fig. 16) so that the single tank is balanced.
- Set switch S10 in the OFF position.

- Switch on the collimator lamp and check compliance of the light and radiation fields according to the specifications in the section on "Replacement of collimator".
- Reattach all covers on the single tank.
- Adjust the adjustment screw so that the single tank is balanced. If any problems occur (see section "Adjustment of arm system").
- Use the service program "P16 - Show the exposure counter" and record the values of the exposure counter in the service protocol and in the unit documentation.

- Use the service program "P10 - Fast adaptation" to adjust the filament values to the new single tank.
- Reattach the remaining covers.

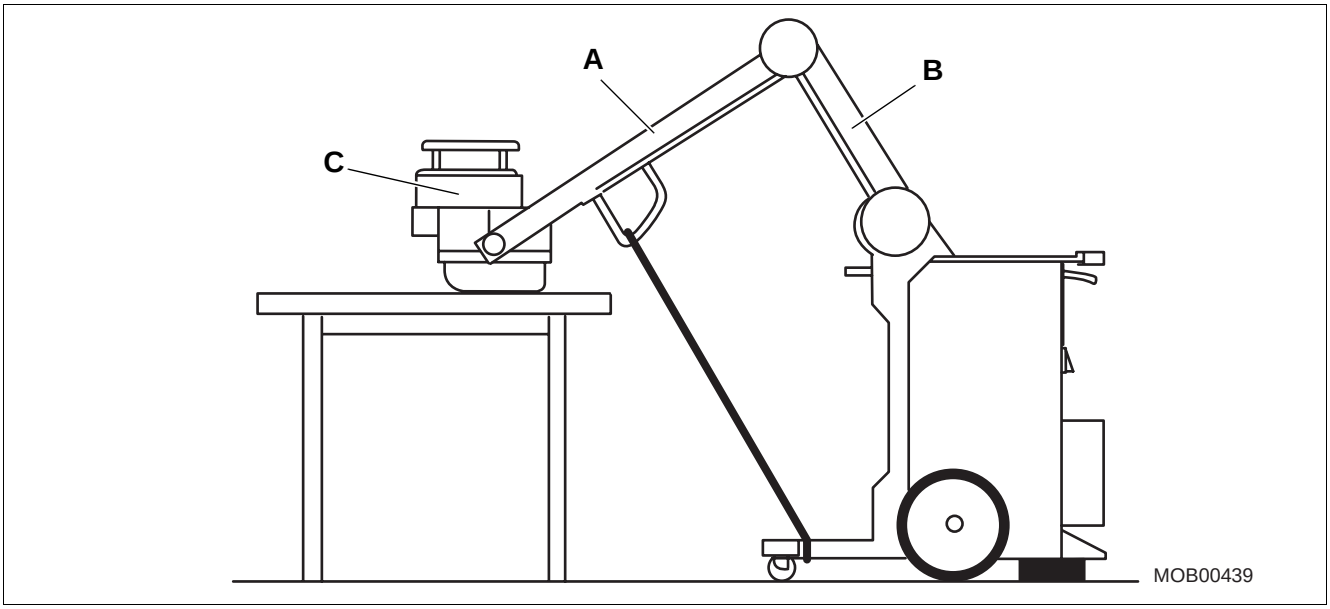



Fig. 19

## Replacement of the support arm cable harness

⚠DANGER

**High Voltage!**

**Life-threatening hazard of electric shock. Never work with the system open if the batteries are still connected and the capacitor is charged. If the batteries are connected, the complete system is powered on!**

**The capacitors in M10 and M11 may still be charged even if the system is switched OFF and the mains cable is disconnected. The capacitors in M10 and M11 must be considered charged until the protective measures listed in this section have been performed.**

**Equipment required:** Rope

- Position the unit with the single tank resting on a table. Secure the support arm with a piece of rope (Fig. 19).
- Remove covers "A" and "B".
- Remove collimator cover "C".

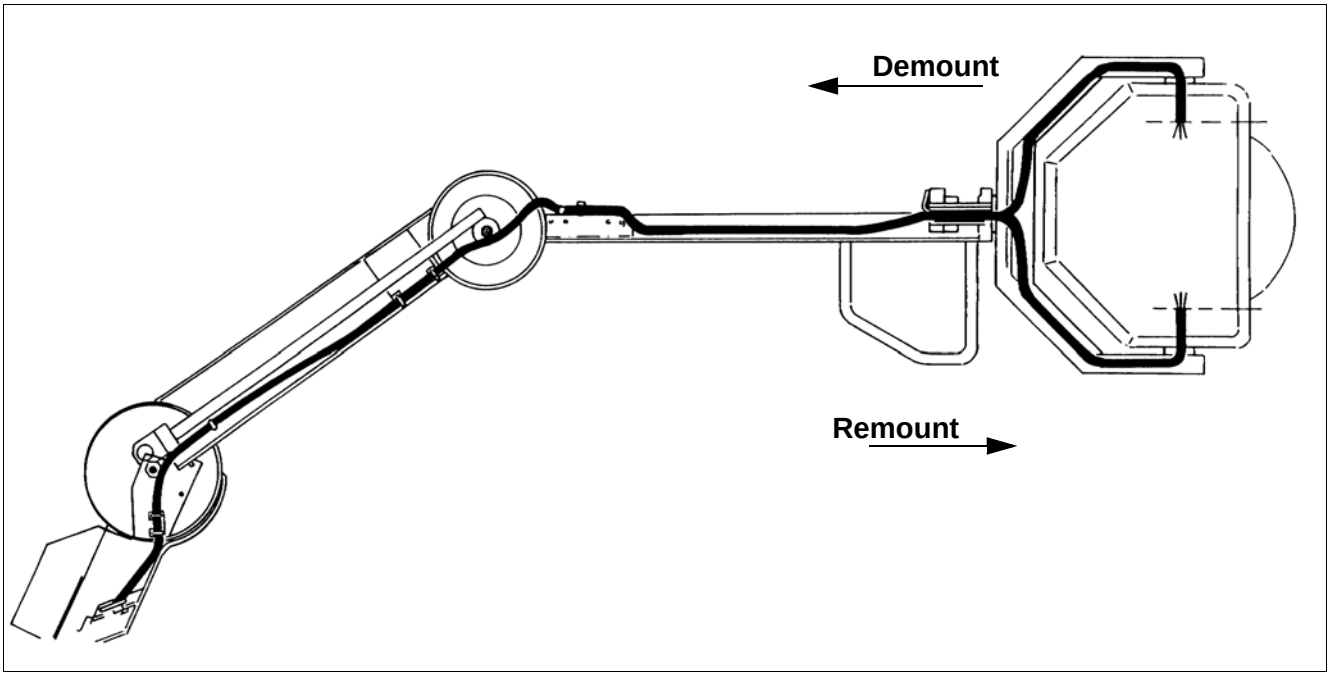



Fig. 20

- Remove **all** arm covers and the column covers.
- Relieve the tension in the spring pack by loosening the adjustment screw above the supporting wheels.
- Disconnect all cables to the collimator.
- Remove the collimator.
- Disconnect all electrical connections to the single tank.

**⚠WARNING**

**Danger of injury!**

**The arm may move uncontrollably when the weight of the fork and single tank is removed.**

**Ensure that the arm is properly secured to the unit foot with the rope.**

- Remove the supporting hub in the rotation axis of the fork.
- Remove all cable clamps and cable ties on the arm and the chassis.
- Disconnect the single tank and the fork from the arm.
- Disassemble the fork so the cables can be removed.
- Disconnect the chassis connections and remove the cables (Fig. 20).

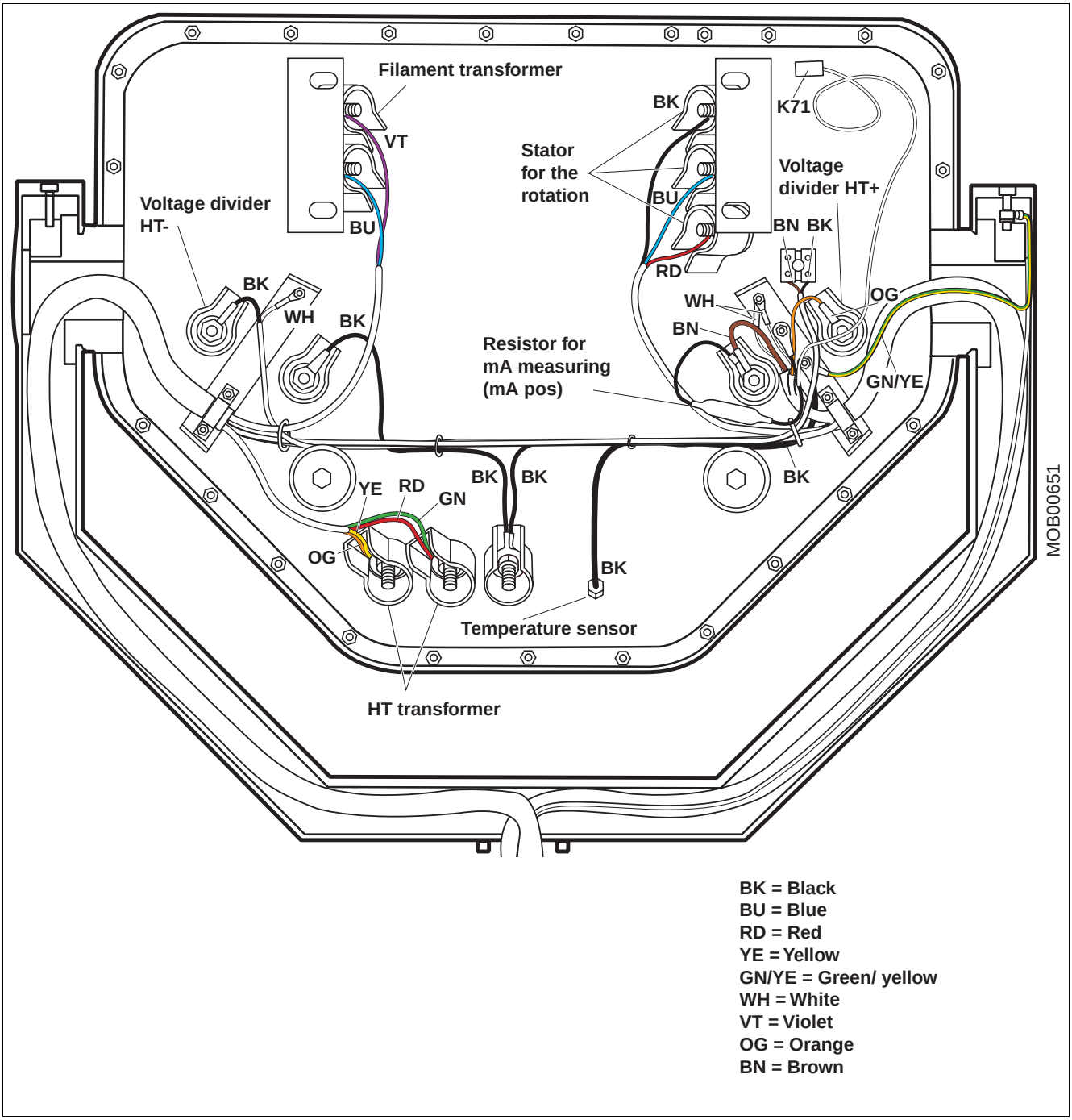



Fig. 21

The installation of the new arm cable harness is performed in the reverse order.

- Connect all wires on the single tank according to (Fig. 21).
- Install the collimator and its wires. Attach only cover "C".
- Connect all connections and reinstall all cable clamps. Install new cable ties.

**NOTICE**

**Do not stretch the cable too tightly in the arm.**

**There must be enough slack so that the cable is not pulled by the mechanical movements.**

- Set S10 to the OFF position.
- Reinstall all covers except single tank covers "A" and "B".
- Make sure that the screw mountings between the fork and the arm are tightened properly.
- Remove the rope between the handle and the foot while keeping the single tank on the table.
- Tighten the adjustment screw until the single tank and arm are balanced. Refer to the section "Adjustment of arm system".
- Switch on the collimator lamp and check compliance of the light and radiation fields with the specifications in the section "Replacement of collimator".
- Reattach the remaining covers.

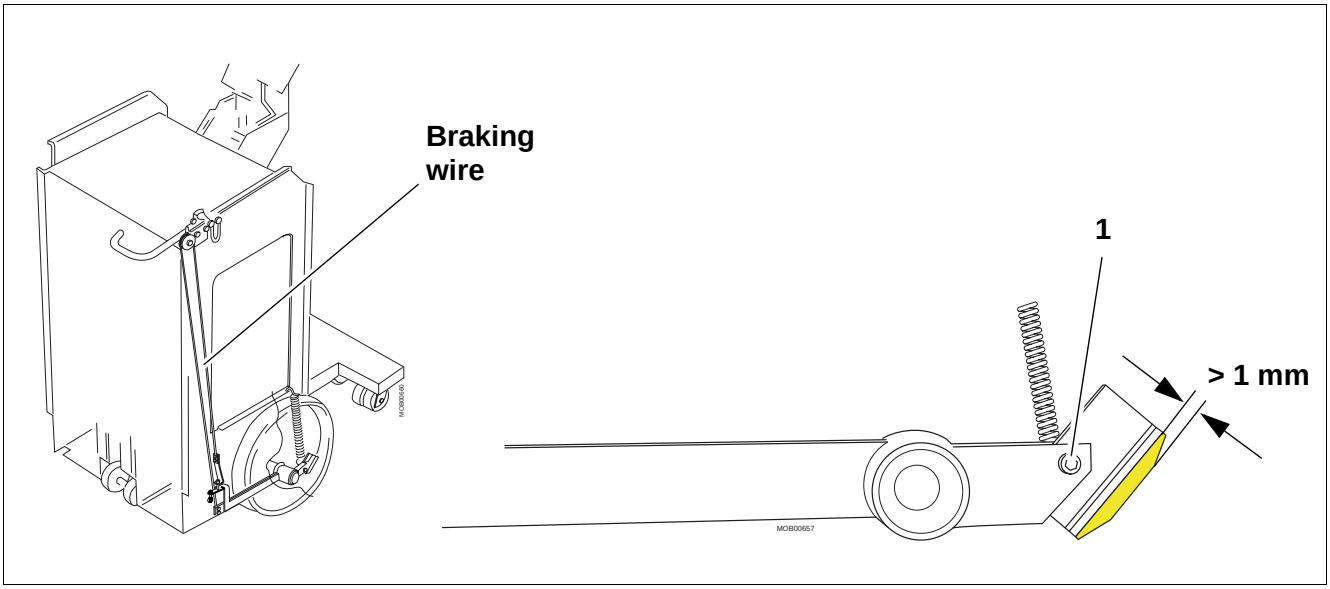



Fig. 22

## Adjustment of the hand/parking brake

**⚠DANGER**

**High Voltage!**

**Life-threatening hazard of electric shock. Never work with the system open if the batteries are still connected and the capacitor is charged. If the batteries are connected, the complete system is powered on!**

**The capacitors in M10 and M11 may still be charged even if the system is switched OFF and the mains cable is disconnected. The capacitors in M10 and M11 must be considered charged until the protective measures listed in this section have been performed.**

**Equipment required:** Spring scale

- Disconnect the unit from the wall outlet.
- Block up the unit on both sides with 5 x 5 cm pieces of wood. The wheels must be able to rotate independently.
- Remove the rear wheel by removing the screw.
- Check the brake linings. If the brake linings are thinner than 1 mm, they must be replaced (Fig. 22).
- Remove the old lining by loosening the screw (pos. 1 / Fig. 22).
- When installing the new lining, make sure that the lining is **facing the right way**.
- If the braking linings meet the requirements and the braking force is still low, check the tension of the brake wire.
- Remount the rear wheels.

- Lock the brake. It should not be possible to move the unit with average manual force. A slight skip is acceptable when using greater force, i.e. more than 350 N.
- Measure the power required for lifting the brake handle to locked position with a dynamometer. If the power is not between 100 and 120 N, an adjustment will be necessary.

### Adjusting brake force

There are two different types of brake arms, depending on how new the unit is. Identify the type on the affected unit from Fig. 23 and follow the proper procedure.

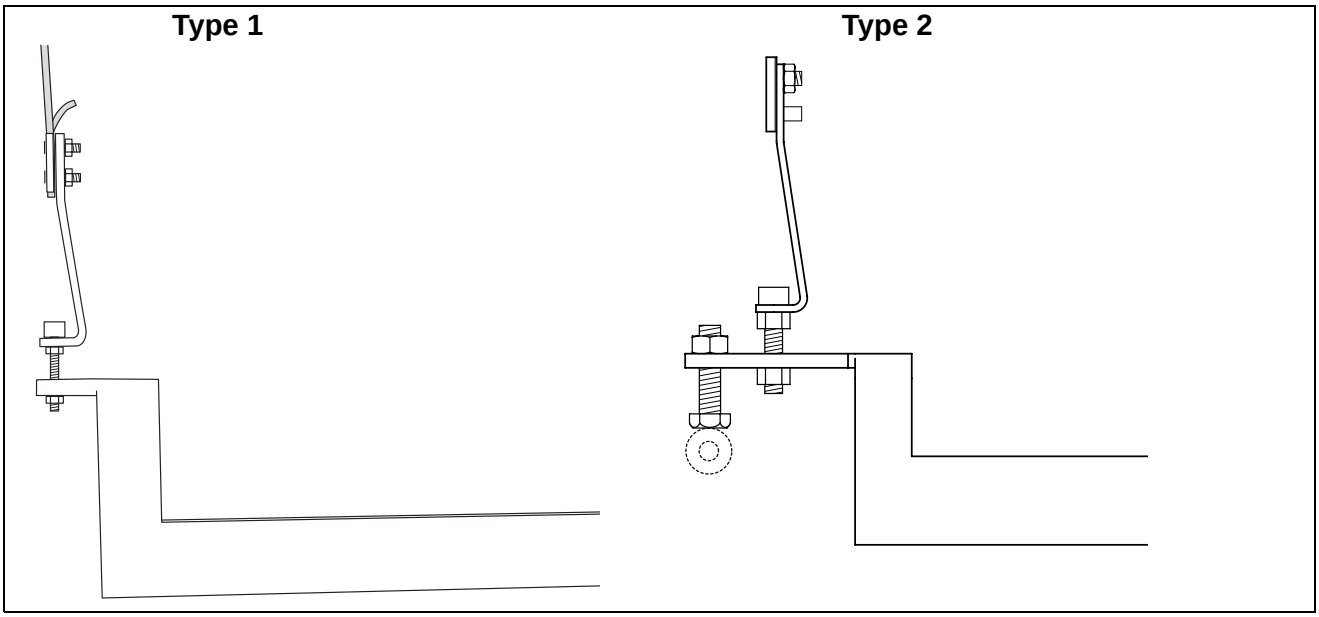



Fig. 23

#### Adjustment for Type 1

- Tighten the adjusting screw with the brake released (pos. 1 / Fig. 24) until the required brake force is obtained.

- After adjustments, make sure the brake wire link is oriented according to pos. 2 / Fig. 24. Lock its position using the nuts (pos. 3 / Fig. 24).

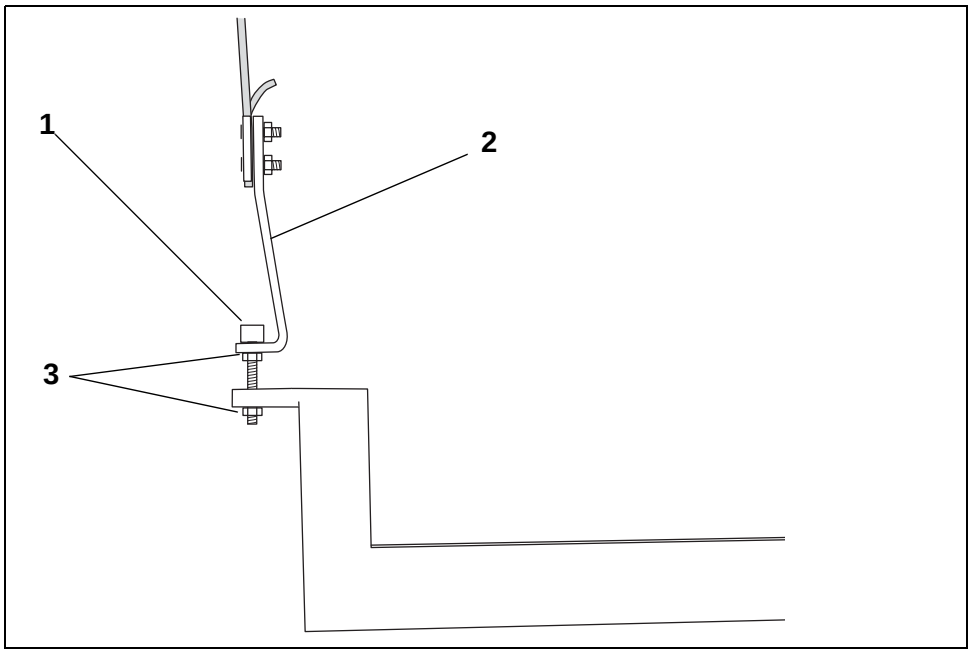



Fig. 24

**Adjustment for Type 2**

- Adjust the screw (pos 1 / Fig. 25) so that the arm can fall back just enough to release the brake. Lock its position with the nut.
- Tighten the adjusting screw with the brake released (pos. 2 / Fig. 25) until the required brake force is obtained.

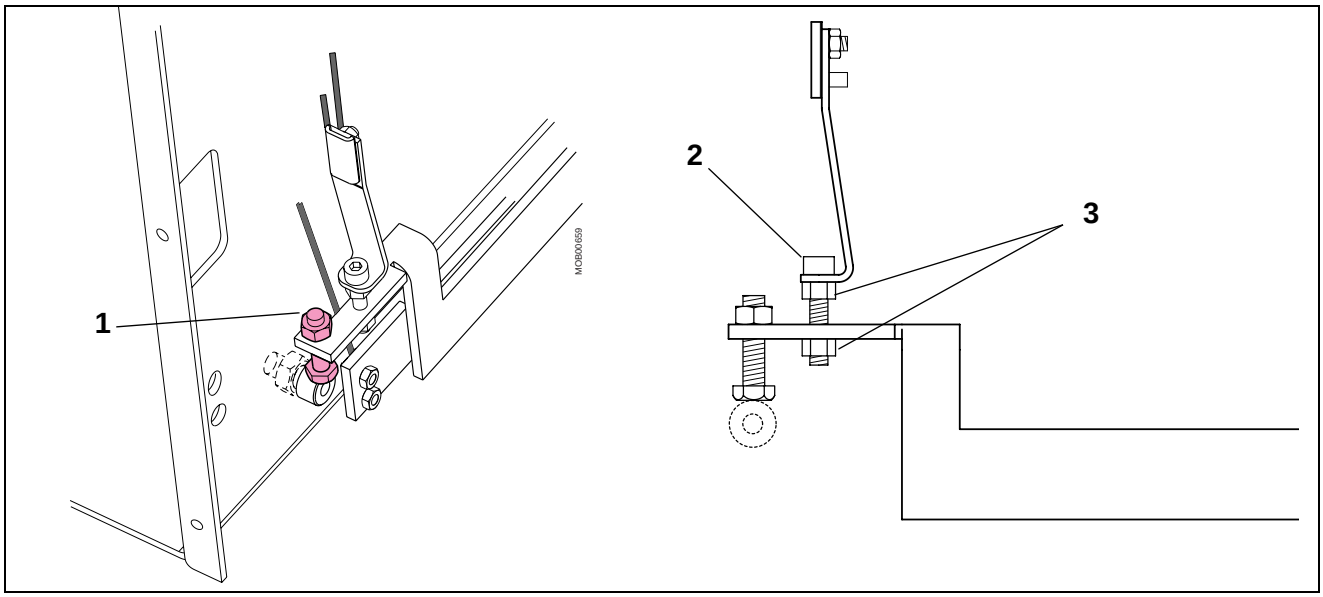



Fig. 25

- After adjustments, make sure the brake wire link is oriented according to pos. 2 / Fig. 24. Lock its position using the nuts (pos. 3 / Fig. 25).

## Replacing the supporting wheels

**Equipment required:** 1 piece of wood (approx. 50 x 70 x 500 mm)

- Jack up the unit with the piece of wood.
- Block the rear wheels so that they cannot turn.
- Remove the locking rings (pos. 1 / Fig. 26).
- Remove the wheel shaft so that the supporting wheel can be removed.
- Install the new support wheel and secure the shaft with the locking ring.
- Check that the wheels move easily.
- Remove the wood block and lower the unit.

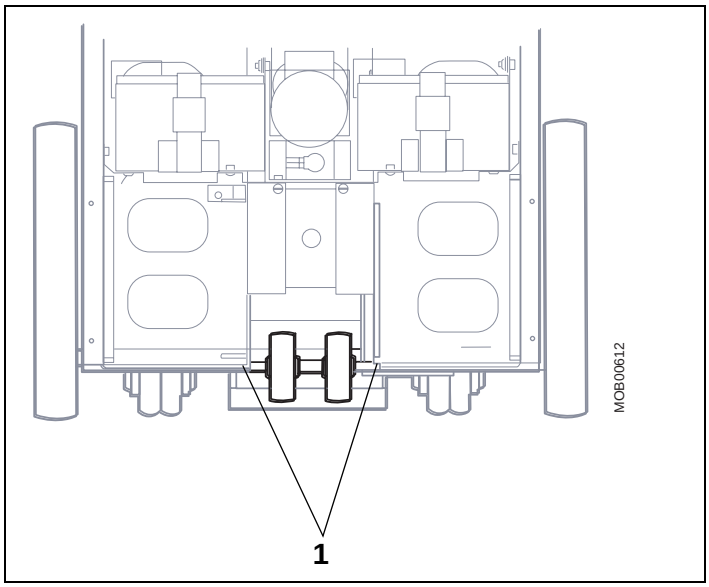



Fig. 26

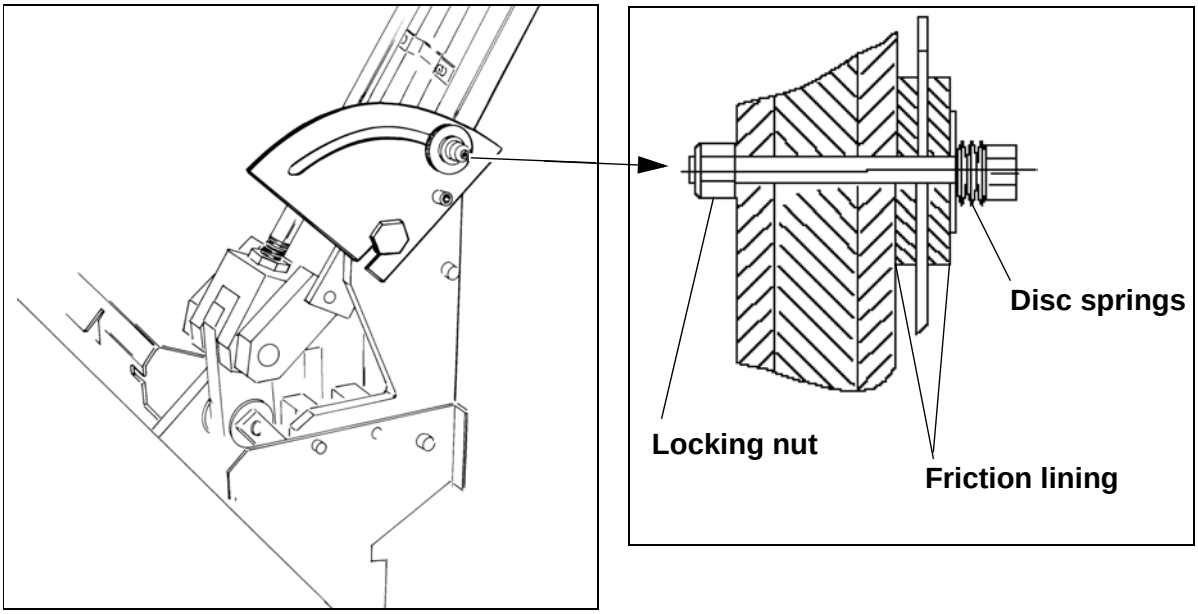



Fig. 27

## Replacing the friction linings

### Replacing the horizontal friction lining

- Remove the joint covers.
- Remove the locking nut.
- Remove the screw and disc springs.
- Replace the horizontal friction lining.
- Remount the screw and disc springs (Fig. 27). Secure the screw with the locking nut.
- Adjust the horizontal friction linings. Refer to the section: "Adjustment of the friction linings", Page 10 - 4.
- Reattach all covers.

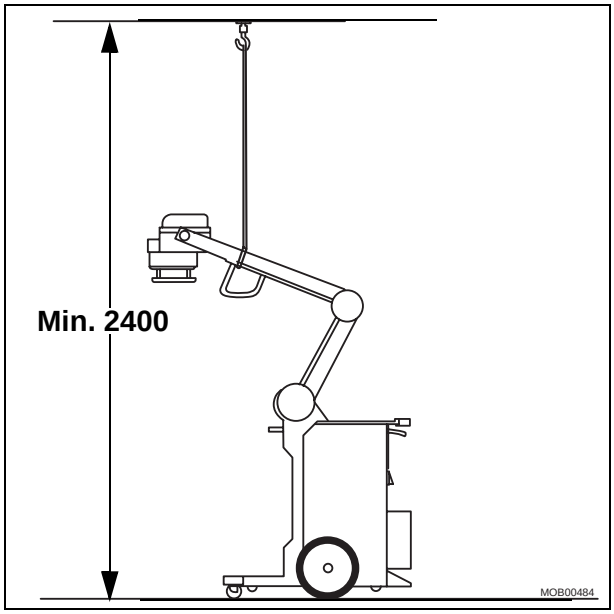



Fig. 28

### Replacing the vertical friction linings

⚠**DANGER**

**High Voltage!**

**Life-threatening hazard of electric shock. Never work with the system open if the batteries are still connected and the capacitor is charged. If the batteries are connected, the complete system is powered on!**

**The capacitors in M10 and M11 may still be charged even if the system is switched OFF and the mains cable is disconnected. The capacitors in M10 and M11 must be considered charged until the protective measures listed in this section have been performed.**

**Equipment required:** Large caliper, rope, ceiling support.

- Raise the single tank to maximum height and secure it with a ceiling support (Fig. 28).

⚠**CAUTION**

**The ceiling suspension must be able to hold a weight of 100 kg since the entire weight of the arm will be on the ceiling support once the spring is removed.**

**If not, the arm and single tank will fall.**

**Make sure the ceiling support is sufficient.**

**NOTE**

**Do not stand under the single tank or the arm system during the work that follows.**

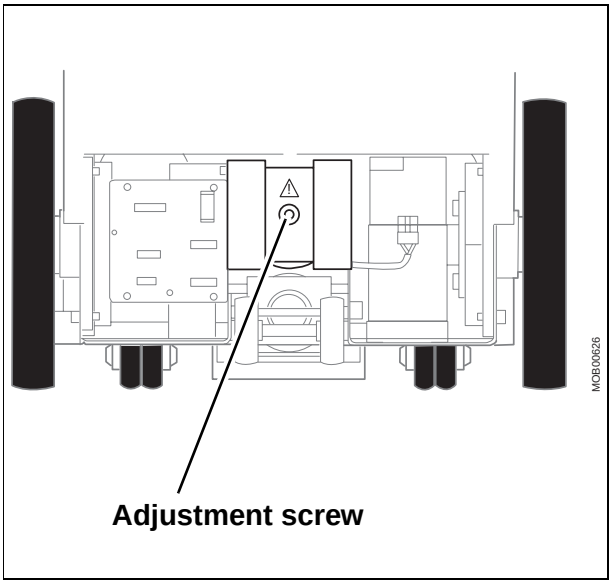



Fig. 29

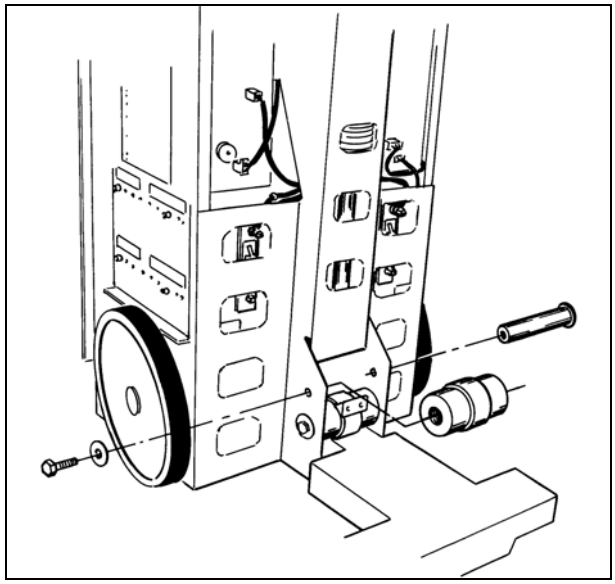


Fig. 30

- Loosen the adjustment screw so that the arm is no longer balanced. However, the spring mechanism remains in position (Fig. 29). Do not allow the spring mechanism to fall out.
- Remove the screw and washer from the upper counter bearing (Fig. 30).
- Remove the friction linings.

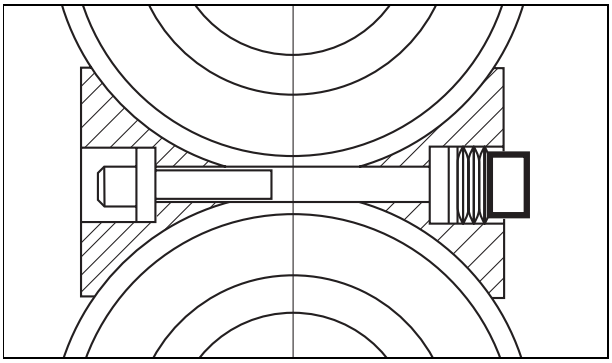


Fig. 31

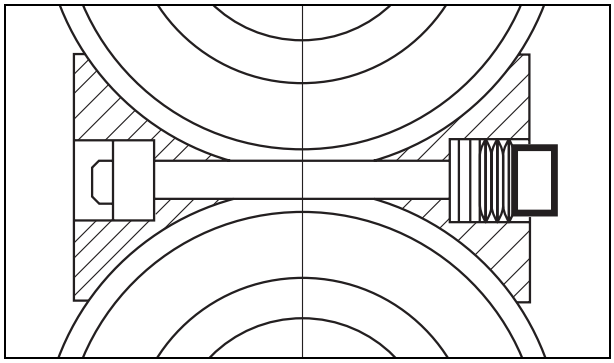
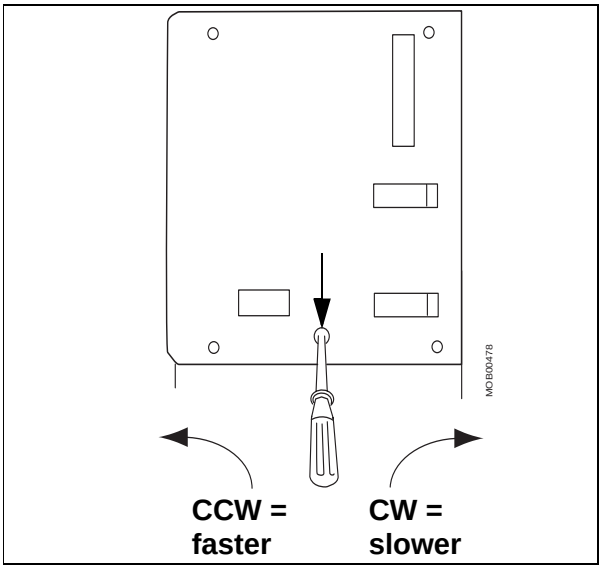


Fig. 32

- Install the new friction linings according to (Fig. 31 or Fig. 32). There are two different vertical friction linings. Both are equally suitable for the unit.
- Reinstall the upper counter bearing.
- Tighten the screws.
- Check that there is no braking action on the counter bearings.
- Tighten the adjustment screw. Make sure that the spring mechanism is under tension before releasing the ceiling support.
- Attach the column cover and side covers and the cover with the cassette compartment.
- Check parallelism (see section "Parallelism").
- Adjust counterbalance (see section "Counterbalance").
- Adjust friction linings (see section "Adjusting the friction linings").



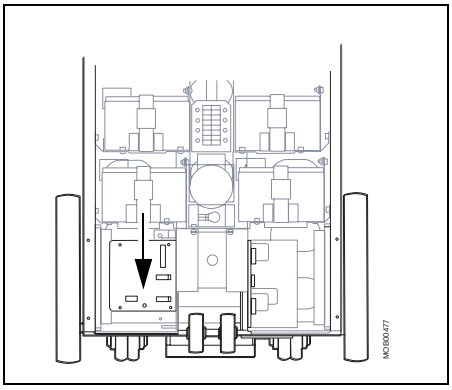




Fig. 1

## Adjustment of the speed

**⚠DANGER**

**High Voltage!**

**Life-threatening electric shock hazard exists. Never work with the system open if the batteries are still connected and the capacitor is charged. If the batteries are connected, the complete system is powered on!**

**The capacitors in M10 and M11 may still be charged even if the system is switched OFF and the mains cable is disconnected. The capacitors in M10 and M11 must be considered charged until the protective measures listed in this section have been performed.**

**NOTE**

**There is only one backward speed.**

- Adjust the speed with a screwdriver as shown in (Fig. 1).
- Clockwise rotation decreases the speed.
- Counterclockwise rotation increases the speed.

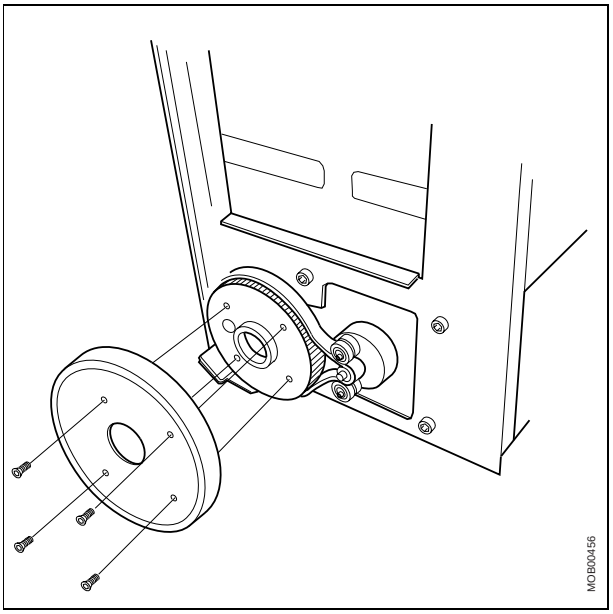



Fig. 2

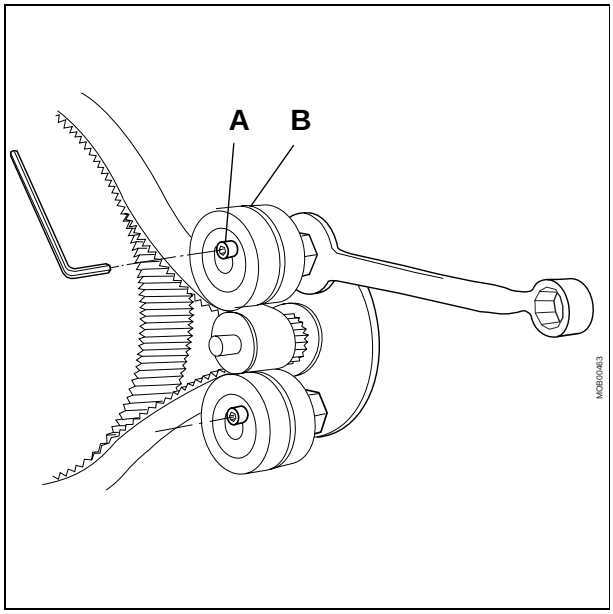



Fig. 3

## Replacement of the transmission belt and belt tension adjustment

| NOTE | **Under normal circumstances, the belt drive does not require any adjustments for the entire lifetime of the unit.** |
|---|---|

### Belt replacement

- Remove the side covers.
- Tilt the unit and support the relevant side with a piece of wood.
- To prevent the other wheel from turning, secure it with a pair of wedges.
  **Do not use the parking brake.**
- Remove the wheel as shown in Fig. 2.
- Loosen the 2 screws (**A**/Fig. 3).
- Loosen the tension bearings (**B**/Fig. 3) with a 13 mm wrench.
- Remove the belt.
- Install the new belt.
- Tighten the tension bearings (**B**/Fig. 3) and the screws (**A**/Fig. 3).
- Rotate the large toothed wheel by hand and check for smooth operation and that the belt is aligned over the toothed wheels.
- Adjust the tension as described under "Tension adjustment".

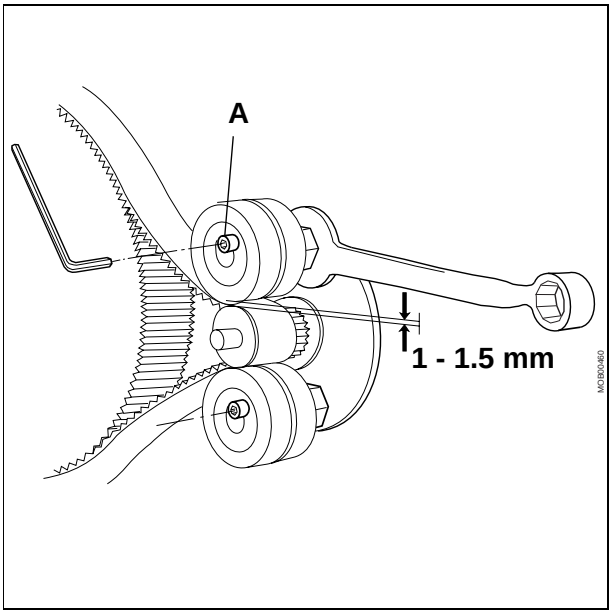



Fig. 4

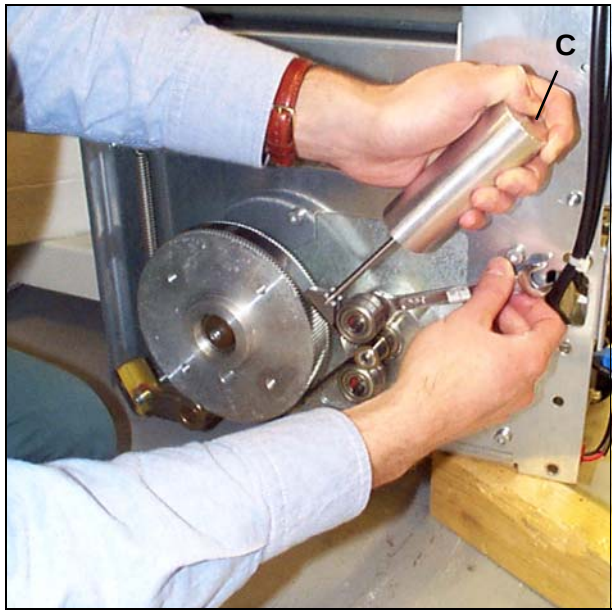



Fig. 5

### Tension adjustment

- Loosen the screws (**A**/Fig. 4). The tension of the transmission belt can then be adjusted with a 13 mm wrench.
- Press the special adjustment device to the transmission belt and hold a finger on top of it. When the button (**C**/Fig. 5) is in the same level as the top of the adjustment device, a proper pressure is applied.

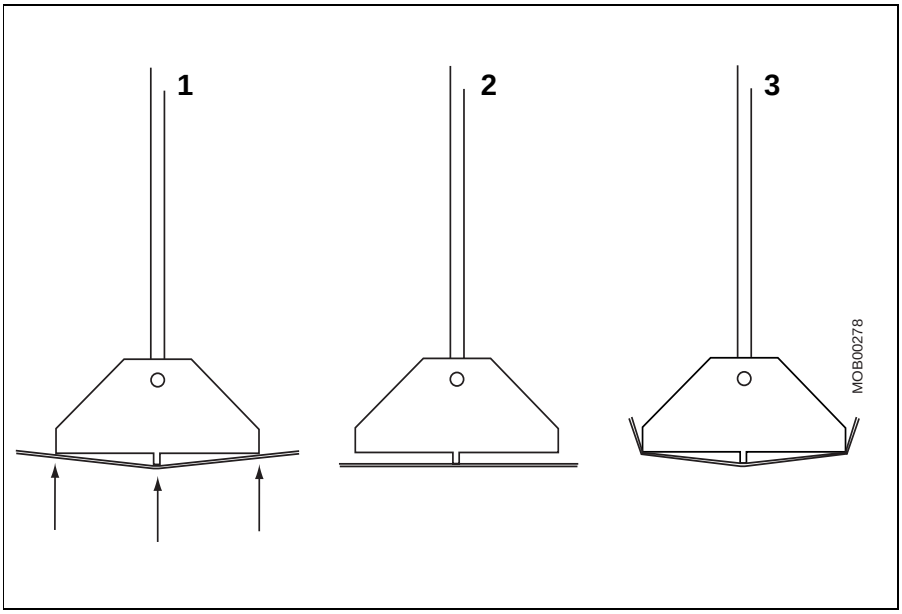



Fig. 6

- With the wrench, adjust the tension of the transmission belt equally on the two tension bearings to a minimum distance of 1-1.5 mm between the bearing and the washer (Fig. 4). The tension of the transmission belt is right when the adjustment device and the belt are in contact in exactly three points (**1**/Fig. 6).
  In (**2**/Fig. 6) the belt is too tight and in (**3**/Fig. 6) the belt is too slack.
- Tighten the screws (**A**/Fig. 4).
- Remount the wheel.
- Fit the covers.

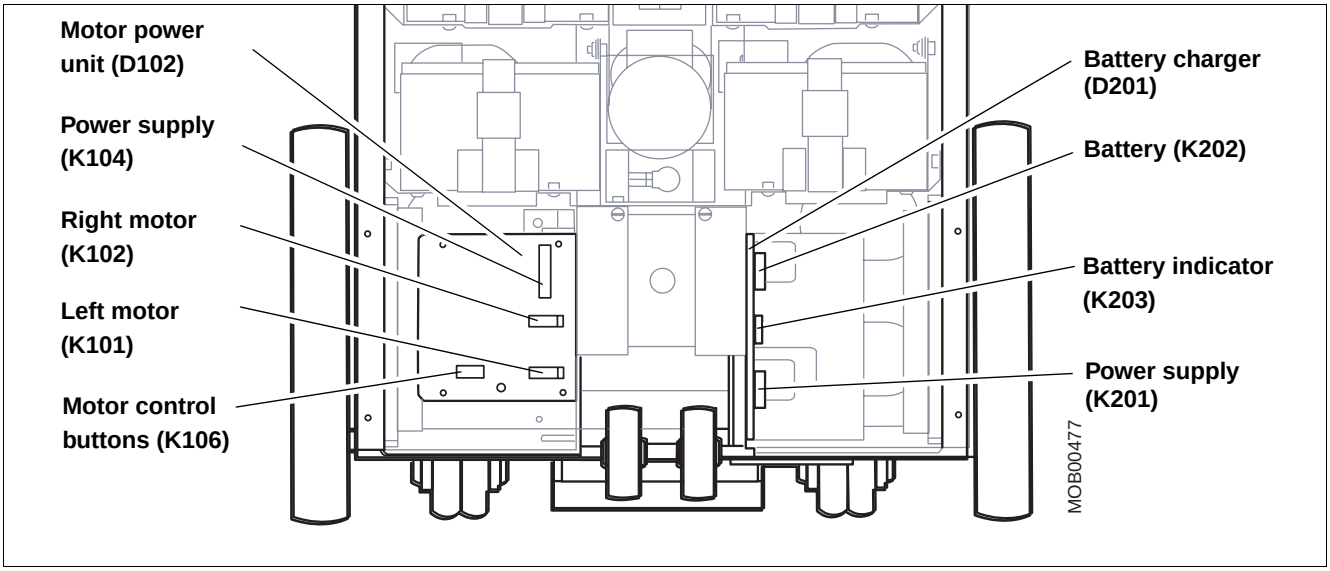



Fig. 7 Motor power unit, electrical connections

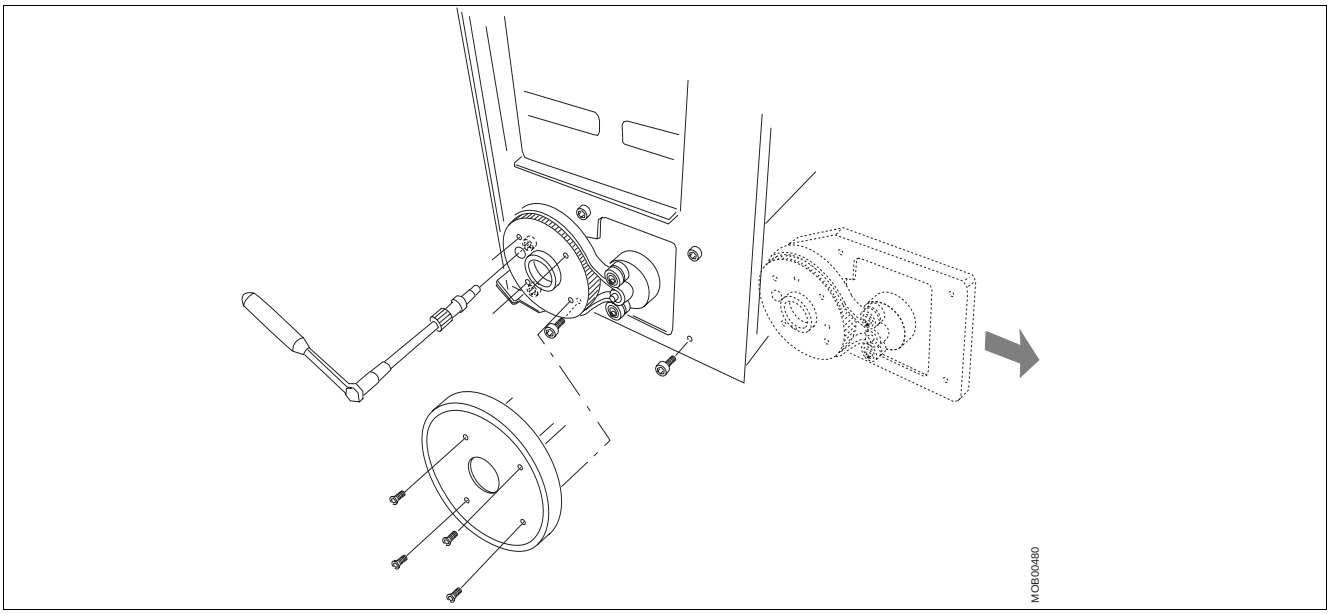



Fig. 8 Removing wheel and motor

## Replacing the motor unit

**Equipment required:** Ratchet with Allen socket

- Remove the side and front covers.
- Remove the motor power unit (D102) or battery charger (D201) depending on the side where the motor is being replaced. Refer to (Fig. 7) for electrical connections.
- Tilt the unit and support the affected side with a block of wood.

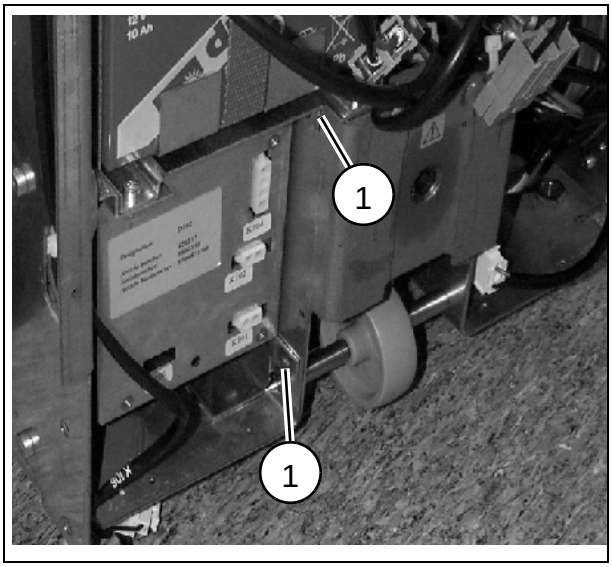



Fig. 9

- To prevent the other wheel from turning, secure it with several wedges.
  **Do not apply the parking brake.**
- Remove the wheel, four screws as shown in (Fig. 8).
- Remove the six screws that hold the motor. Two of the screws can be accessed through a hole in the toothed wheel.
- Remove the complete motor unit inward through the opening in the chassis.
- Install the new motor with the six screws.
- Install the motor power unit (D102) or battery charger (D201). Refer to (Fig. 7) for electrical connections.
- Install the wheel with the four screws.
- Remove the block of wood.
- Reattach the covers.

## Repairs to the motor power unit

The motor power unit should not be repaired. If the motor power unit is defective (with the exception of 4 A fuse), the entire unit should be replaced.

### Exchange of motor power unit D102

- Remove the front cover.
- Disconnect K101, 102, 104, 106 on D102.
- Remove the two front screws (1/Fig. 9).

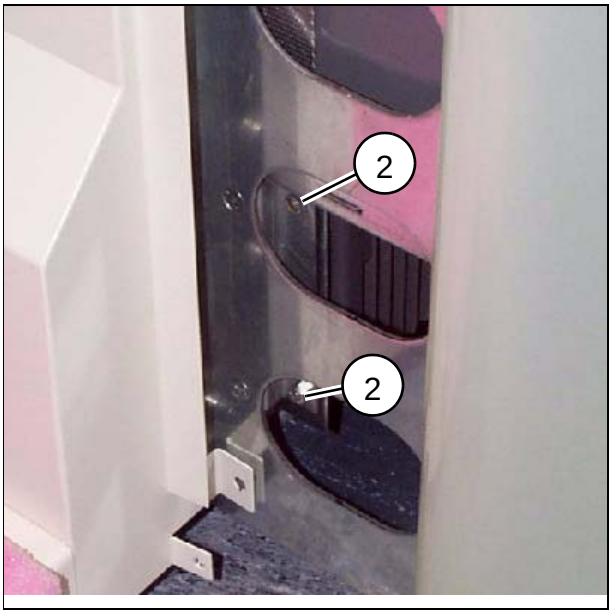



Fig. 10

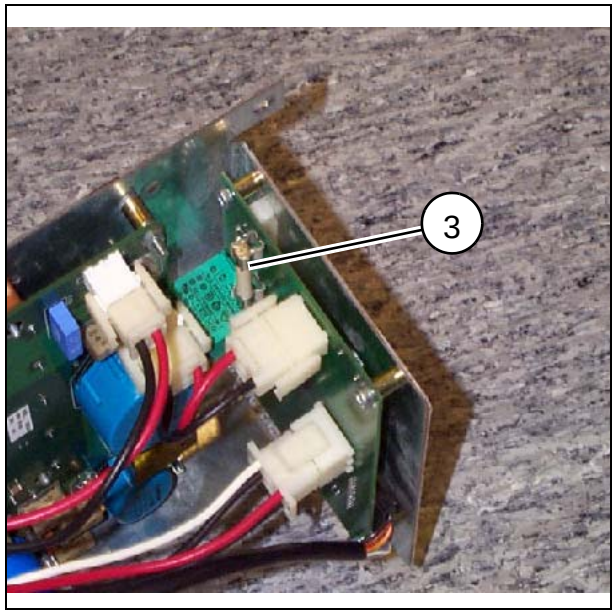



Fig. 11

- Remove the two back nuts (2/Fig. 10).
- Pull out the motor power unit.
- Replace the motor power unit.

### Replacement of fuse (4 A)

- Pull out the motor power unit.
- Replace the fuse (3/Fig. 11).

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## Recalibration of DAP measuring system

This chapter shows how to recalibrate the DAP measuring system by using an external ionization chamber (dose meter).

### Required equipment

- Dose meter
- Calibration tool for DAP measuring system

### Recalibration procedure

- System OFF.
- Disconnect the DAP ionization chamber connector which is connected to board D70 (pos. 1 / Fig. 1).

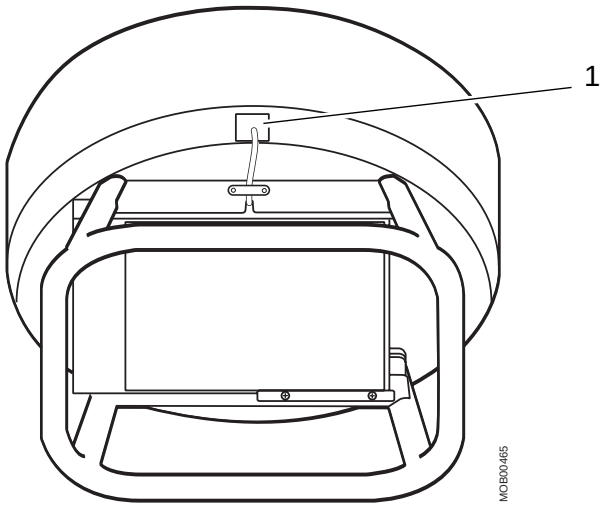


Fig. 1 Connector

- Connect the DAP calibration tool between the connector and board D70.

**NOTE**

**It is irrelevant which connector is the input or the output of the DAP calibration tool.**

- System ON.
- Set up the MOBILETT and the dose meter as shown in Fig. 2.

**NOTICE**

**Measurement errors.**

**If a semiconductor detector is used, the temperature/pressure factor of the dose meter must be considered.**

**Otherwise a deviation against the factory calibration may occur.**

- Switch the collimator light on. The dose meter should be positioned in the center of the light field and freely in the air to avoid back scattering radiation.

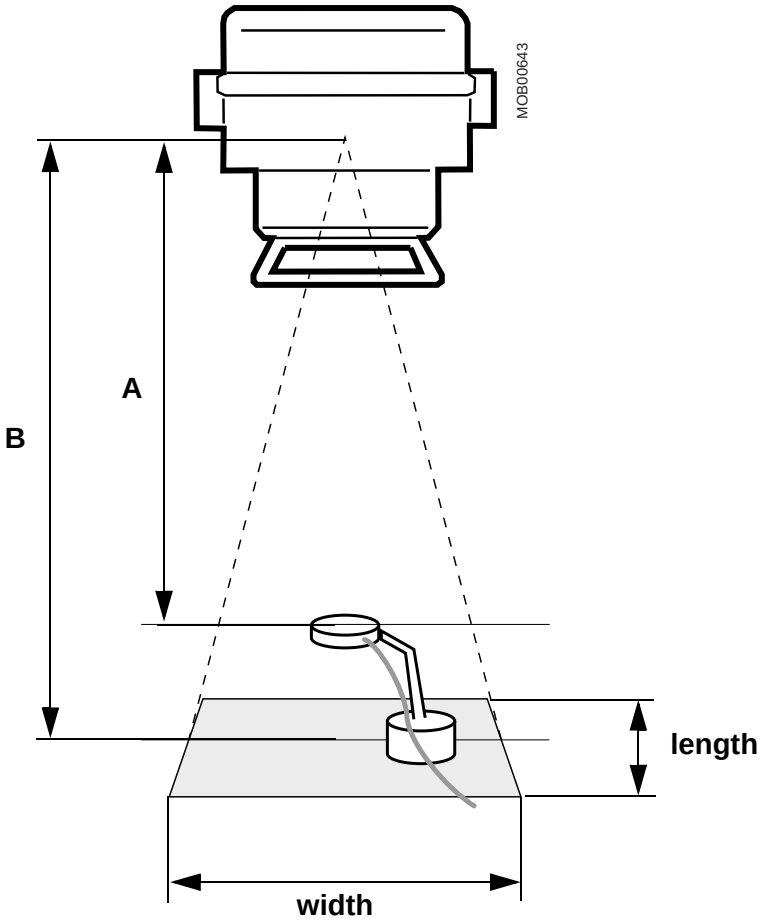


Fig. 2 Setup

- Measure the Focus - dose meter distance (**A** / Fig. 2) and then the **width** and the **length** of the light field on the surface. For optimal accuracy, place an unexposed film cassette on the surface, and measure the exposed area width and length on the film after an exposure has been released.
- Measure the Focus- light field/surface distance (**B** / Fig. 2).
- Calculate the reference area according to the following formula:

$$\text{Reference area} = \frac{A^2}{B^2} \cdot (\text{width} \cdot \text{length}) \quad (\text{unit } m^2)$$

- Set kV to 102 and mAs to 20 and release an exposure.
- Record the dose value measured with the dose meter.

- Calculate the reference DAP value using the measured dose value according to the following formula:

$$\text{Reference DAP value} = \text{measured dose value} \cdot \text{reference area} \quad (\text{unit } \mu Gy\ m^2)$$

- Record the DAP value measured with the DAP measuring system (DAP value from display).
- Calculate a comparison with the following formula:

$$\text{Comparison value (\%)} = \frac{100 \cdot \text{DAP value from display}}{\text{Calculated DAP value}} - 100$$

The comparison value shows the deviation between the actual DAP value (measured with the dose meter) and the DAP value measured with the DAP measuring system. If the comparison value is negative, the DAP display shows a value that is lower than the actual value, and vice versa.

If the comparison value is less than ±5%, the calibration is completed.

- To correct the deviation, press the “UP” button on the calibration tool (for negative comparison values) or the “Down” button (for positive comparison values). Pressing a button once corresponds to approximately 0.5% change of the comparison value.

| NOTE | **The middle push-button on the DAP calibration tool is for test purpose. It has the same function as the test button on the DAP display.** |
|---|---|

- Repeat the calibration sequence until the deviation is less than ±5%.
- System OFF.
- Remove the DAP calibration tool and reconnect the DAP ionization chamber to board D70 (pos. 1 / Fig. 1).
- System ON.
- Press the reset and the test button to complete the calibration procedure.

- Release a test exposure.

## Miscellaneous service issues

No further service or maintenance shall be performed on the DAP ionization chamber and the DAP display. Note that the warranty becomes void if the DAP ionization chamber or the DAP display are opened or altered in any fashion.

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Page 1- 2, Section "Required tools, measurement and auxiliary devices" revised

Page 5 - 1, Section "Entering service mode": "Err" changed to "vEr".

Page 7 - 6, Section "Replacement of batteries B10":
"A512/10.0 SR" changed to "A512/10 S"

Chapter 12 Completely revised.

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